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E P Dufour

AUTHORIZED PHYSIOLOGY SERIES, No. 2.

LESSONS IN HYGIENE

OR

THE HUMAN BODY, AND HOW TO TAKE CARE OF IT

THE ELEMENTS OF ANATOMY, PHYSIOLOGY, AND HYGIENE, FOR INTERMEDIATE AND GRAMMAR GRADES

BEING AN EDITION OF "HOW WE LIVE," REVISED TO COMPLY WITH THE LEGISLATION REQUIRING TEMPERANCE INSTRUCTION IN SCHOOLS

BY

JAMES JOHONNOT AND EUGENE BOUTON, PH.D.

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INDORSEMENT.

The "Authorized Physiology Series" consists of:

No. I.—"Health for Little Folks."	For Primary Grades.
II.—"Lessons in Hygiene," A special edition of "How we Live," by Johonnot and Bouton.	For Intermediate Grades.
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W. P. 17

WHY AND HOW.

For a long time the conviction has been growing that there is a radical defect in an elementary course of study which admits technical grammar, but excludes the warning knowledge of the consequences of violated hygienic law. The urgent need has long been felt of giving more attention to subjects pertaining to life, health, and happiness.

LEGISLATIVE ACTION.

These convictions seem to have been shared by the lawmakers of many States and of the National Congress. The recent enactments making the nature of alcoholic drinks, tobacco and other narcotics, and their effects upon the human system, in connection with physiology, a part of the course of instruction in the public schools, are evidences of this conviction; and from every point of view the measures appear wise and beneficent.

If wisely carried out, this legislation must produce great good. The attention of pupils will be directed to the laws which govern their own being. The truths set forth will find lodgment in the brain, and in time they will find expression in daily practice. As a result, we may look for improvements in food, in dress, in ventilation, in habits, in hours of work and recreation, and in everything that pertains to living.

PLAN OF THE BOOK.

The manifest importance of the subject is the "why" of the book. The "how" remains to be considered.

The book is elementary, not a scientific treatise for advanced students. Beginning with obvious relations, its method is inductive, each new topic growing out of the one that precedes it. It aims to present the laws of life in such a practical and reasonable way that they will become a guide to living.

In the treatment of each topic, function is considered before structure. The first step is to show that, for purposes of life and growth, there is a need. Then, in answer to the query as to what is done to satisfy the need, a full description is given of the organs used and the methods employed. This properly subordinates structure to use, and shows the true relations of all the agencies of life.

The limitations set by the term "elementary" have forbidden minute details, abstruse discussions, ultimate analyses, and the general use of technical terms. All these are left for the "High-School Physiology." Where technical terms are introduced in marks of parenthesis, they are not intended for the pupils to memorize.

HYGIENIC LAWS.

An endeavor has been made to present the relations of part to function in such a way that the hygienic law applicable to the case follows as a matter of course, and scarcely needs to be stated. A law derived in this way compels assent and commands obedience; while one arbitrarily learned from the book is likely to remain in the mind as a mere formula.

INCENTIVES TO STUDY.

At the close of each chapter a list of questions is appended, not on the text, but rather on subjects which the

text suggests. The answer to these questions will test the pupil's power of inference, and will incite to careful observation and study in various directions. When the questions are not mere matters of inference, one at a time should be given out at the close of each recitation, so as to allow ample time for inquiry and study. The good which will come from a judicious use of these topics may be lost by a rigid demand for a specific answer in a specified time.

ALCOHOL, TOBACCO, AND OTHER NARCOTICS.

The provision in the new laws in regard to alcohol, tobacco, and other narcotics seems to be another wise and timely measure. It assumes that bad habits are largely due to ignorance. It would diminish the evils by removing the cause. It submits the solution of a great social problem to science. It espouses no theories, but demands the exact truth. It calls upon the teacher to furnish the weapons that shall conquer prejudice, and arm the inexperienced against temptation.

In this work, alcohol, tobacco, and other narcotics, in their relations to life, are duly treated. The nature of these as revealed by modern science is shown, and their effects upon organ and function are fully described. These effects, on the whole, are seen to be so pernicious that a knowledge of them would seem to be an almost sufficient safeguard against evil example, which is continually inciting to evil habits.

The error of overstatement has, however, been carefully avoided. Assertion without reason weakens a cause. The facts are sufficient.

PRACTICAL APPLICATION.

This and all kindred works will be of little use if thought stops with the text. What is said is valuable

only as it "wakes up mind," and leads to further study, and to the observance of hygienic laws in daily practices. The teacher who allows his pupils to sit in drafts, who pays no heed to ventilation and the arrangement of light, who is careless in regard to his own diet, dress, and hours of sleep, and who smells of tobacco — or worse, of intoxicating drinks — will teach physiology to little purpose.

The pupils should be made to see, to study, and to experiment. The word should lead to work. Principles should direct practices. The understanding of conditions must precede conscious obedience to law, but obedience is the desired end. Full mental conception of the subject in its relations will, in time, yield fruit in the direction of more healthful bodies, more vigorous minds, and lives made richer by the accomplishment of good deeds.

The medical value of alcohol will not be discussed in this book. As its lay prescription is condemned by the medical profession, the question of its use as a remedy may properly be relegated to medical treatises as out of place in a school text-book.

The special matter relating to alcohol, tobacco, and other narcotics has been almost entirely prepared by Mrs. Mary H. Hunt, Superintendent of the Department of Scientific Instruction of the National Women's Christian Temperance Union, and her valuable suggestions have been followed in many parts of the book. To her and the eminent gentlemen constituting her Advisory Committee the thanks of the publishers and of the surviving author are due for much labor bestowed and great interest manifested in the preparation of the work.

WHAT AND WHERE.

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CHAPTER VII.

LESSONS IN HYGIENE.

CHAPTER I.

The Body and its Parts.

WHY WE SHOULD STUDY OUR BODIES.

When we look at our bodies, we see that they are made up of parts. Each of these parts has a name and one or more uses. We know the most common of these names and uses; but, unless we have studied them with care, there are many important and interesting things about them that we do not know.

If any one should ask us the name of the highest part of the body when standing erect, we would answer that it is the *head.* We could also tell the names and the uses of the outer parts of the head. Perhaps we could make pictures of them.

We would, likewise, be able to tell that the part of the body next below the head is the *neck;* that the largest part of the body is the *trunk;* that the parts attached to the upper portion of the trunk are the *arms;* and that those attached to the lower portion of it are the *legs.*

But, if some one should ask us about what is inside of the head, neck, or trunk, we would be unable to answer

from observation, and we could not tell either the names or the uses of the parts. Yet each of these inside parts or organs has a work to do in the support of life; and the peculiar work which each does and its curious way of doing it are matters of great interest.

When a bee stings us, or we burn our fingers, we can tell the cause of the pain; and we shall be careful to avoid it in the future. But when we have earache or headache, we can not always tell the cause. By the study of those parts of the body which we can not see, we may so change our course of conduct as to avoid many aches and diseases.

If we see a person's tooth broken off, or his eye blinded by some accident, we shall never knowingly expose ourselves to the same danger; yet, by want of knowledge, we may neglect or abuse our teeth or eyes in such a way that they will be as surely destroyed as by a visible accident.

Most of the internal organs are soft and delicate; and when once injured they are afterwards, in many cases, weak and nearly useless. By knowing what care they need, we may avoid injuring them, and so escape pain and disease.

It is necessary, therefore, that we should know a great deal about the parts of the body. We should know not only their names and uses, but also what will make them stronger or weaker. Then we shall know how to preserve our health, and thus be able to keep ourselves in the best condition to do our work in the world.

Looks are important. We like to see good-looking people. We should desire to look well, so that our appearance may not be displeasing to others. One of the most important elements of good looks is health. A sickly person loses that clearness of complexion, that

sparkle of the eye, and that elasticity of step and vigor of motion which we all admire.

By keeping in health we also enjoy life much better. We suffer less from bodily pain; we see things more clearly, and succeed better in what we undertake; we can take care of ourselves, and thus avoid becoming a burden to our friends; and we are more ready to perform any duty that may present itself. Besides, we are more cheerful. We do not take gloomy views of life, and make ourselves generally disagreeable; and, while we are happier ourselves, we make others happier also.

ABOUT PARTS OF THE BODY.

The Arms. — We see that the arms form a pair, and are fastened sidewise to the trunk just below the neck. They extend in opposite directions, and end in *hands*, which continue in the same direction as the arms. The hands terminate in *fingers*, and the ends of the fingers are protected by *nails*.

The Legs. — The legs are joined to the lower part of the trunk and extend downward, ending in *feet*, which are at right angles to the legs. At one extremity the foot has a *heel*, and at the other it terminates in *toes*, which, like the fingers, are protected by nails.

The Limbs and Joints. — The arms and legs when taken together are called *limbs*. All the limbs are attached to the body in such a way that they can move in every direction. The point of attachment is called a *joint*.

FIG. 1. — Ball-and-socket joint of the hip.

If we examine a leg of mutton, or the leg of a chicken, which we may have on the table at dinner, we find in each a bone with a round head fitting into another bone having a cup-like cavity. These bones form what is called the *ball-and-socket joint.*

FIG. 2. — Hinge joint of the elbow.

Such a joint we have at the *shoulders* and the *hips*, where the arms and the legs are attached to the body. The sockets at the shoulders are not so deep as those at the hips, and this arrangement allows the arms much greater freedom of movement.

We see that a door is attached to the jamb in such a way that it can swing in only two directions — backward and forward. This kind of attachment is called a hinge. The arms at the *elbows*, and the legs at the *knees*, have only a forward and backward movement, and hence these joints are called *hinge joints.*

The double or *compound joints* at the *wrists* and the *ankles* admit of a great variety of movements, and are made up of several small, rounded bones which move about each other. The *knuckles* and the toe joints, like those of the elbows and the knees, are hinge joints.

The lower parts of the arms and legs have also a turning or twisting motion, so that we can turn our hands completely over and our feet in and out. This motion is brought about in the arm by an arrangement of two bones which extend through the lower part of the limb, and which turn about one another.

Parts of the Body in Pairs. — Besides the pairs of arms and of legs, we have two *ears*, two *eyes*, and two *cheeks*. If we take notice, we shall see that the *nose* has

two *nostrils*, and that the two sides of the *mouth* are alike in structure. This arrangement of the external parts of the body in pairs makes it double; so that, if it were divided by a line running down from the middle of the *forehead*, it would be in halves, each with the same parts turned in opposite directions.

The Bodies of Other Animals. — If we examine other animals, we shall see the same general plan of structure — parts in pairs, and opposite sides alike. The parts of other animals correspond to parts of our own bodies in many respects, agreeing in number, position, and general use, but differing somewhat in form. Thus, the cat and the dog have four limbs each; but their arms are fore legs; their hands, paws; and their nails claws.

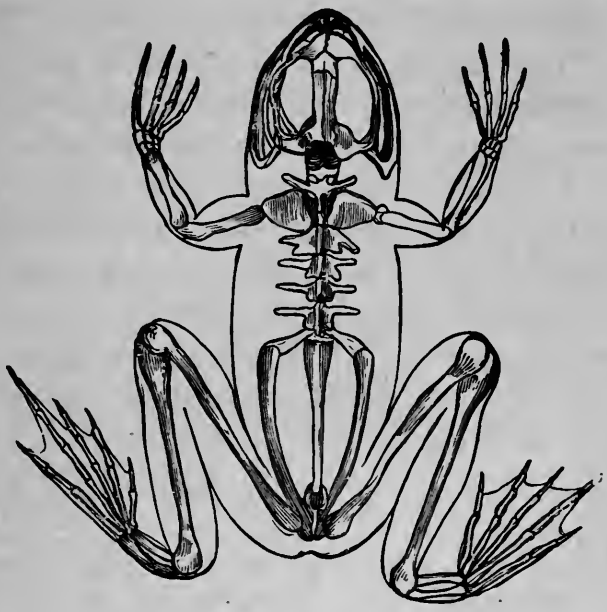

FIG. 3. — Skeleton of the common frog.

The horse and the cow also have four limbs each; but, in the place of toes, the horse has a single hoof, and the cow a double one. The chicken's arms are wings; the bat's four limbs are connected by a thin, delicate skin, forming wings with which it can fly; the frog's four limbs terminate in feet, two of them webbed for swimming; the fish's four limbs are fins; and nearly all

the animals that have backbones are provided with the same number of limbs, showing a general plan in creation, or, as Agassiz expresses it, "a thought of God."

Uses of the Parts of the Body. — In each one of us the part that thinks — or the *mind* — is the most important. The mind in thinking makes direct use of the *brain.* The brain is in the head, and is protected by the *skull.*

Every time the mind thinks, a tiny part of the brain wears out and must be repaired. The materials for the repair come from the *blood.* Hence we must have a way of making blood. This is done in the part of the body called the trunk, which is large, so that it may contain everything necessary for the process.

To make blood, we must have *food;* and to get food, we have arms to reach out and take it, and legs to go in search of it. We thus see that all the parts are made expressly for the service of the mind; and that by their proper action alone can the mind be kept in good condition. One would think, then, that the mind, if it is sensible, would take good care of the body.

SOMETHING TO FIND OUT.

1. Why should we try to look as well as we can?
2. What are some of the things necessary to good looks that we all can attend to?
3. Which of the ball-and-socket joints are most easily put out of joint? Why?
4. What kind of joint unites the thumb to the hand?
5. How many joints have the fingers? the toes?
6. How does the great toe differ from the thumb?
7. How does the ankle differ from the wrist?
8. How do the cat's toes correspond in number to our fingers and toes?
9. How do the cat's fore paws differ from our hands?

10. What joint in the dog's hind legs corresponds to our hips? knees? ankles?

11. What bone in the cat's leg represents our heel?

12. On what part of the foot do we tread? On what part does the dog tread?

13. What animals use their fore paws to hold their food while eating?

14. How does the duck's foot differ from that of a chicken?

15. What do birds have in the place of mouth and nose?

16. In what way can we best avoid mistakes in taking care of the body?

TOPICAL ANALYSIS OF CHAPTER I.

The Body and its Parts.

Why we should study our Bodies.

1. The head, neck, trunk, and limbs seen.
2. The internal organs not seen.
3. To avoid injury of outward parts.
4. To care for organs within the body.
5. To secure health.
6. To improve looks.
7. To increase usefulness.

About Parts of the Body.

1. The arms.
2. The legs.
3. The joints: ball-and-socket — hinge — compound.
4. Parts in pairs.
5. Bodies of other animals.
6. Uses of parts of the body.
7. Intelligent care of the body.

Something to find out.

NOTE. — The topical analysis at the end of each chapter may be made of great value to teacher and pupil, as showing the relations of the topics and sub-topics to each other, and as affording a scientific basis for examinations and reviews.

More of technical detail than is given in the body of the book will be found on page 185, under the title, "What the Words Mean," and in the table of "Bones of the Body," on page 200.

CHAPTER II.

Eating, and what comes of it.

WHY WE EAT.

EVERY motion that we make, and every thought that we think, destroys some of the minute *cells*,* or particles, of which the various parts of the body are composed. If this waste goes on without repair, the body soon wears out, and the life is destroyed. The process of repair is called *nutrition*, and the materials for nourishing the body are found in food.

Before the food can nourish the body, it must undergo many changes. It must be broken up; the useful parts of it must be dissolved; different parts must be mixed with each other; and the useful parts must be separated from those which are worthless. The first step in this process is *eating*. We eat, then, that we may live. We eat, that every part of our bodies may be strengthened, and that we may be able to do our daily work.

WHAT WE EAT.

Upon our tables, for breakfast or dinner, we have meat, bread, potatoes, fish, fruit, and many other articles

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* The cells composing living bodies are parts so small that they can not be further divided, and too small to be seen by the naked eye. Every living thing is in fact a mass or collection of cells, each cell being alive and playing its part in nourishing itself and the rest of the plant or animal to which it belongs. Two or more cells united so as to form one substance make *tissue*.

of food to eat; and water, milk, and other liquids to drink.* We must take this food and drink at regular times, to satisfy the feeling of hunger and the needs of the system.

As the body is composed of some sixteen different kinds of simple substances, our food and drink must contain as much of each kind of substance as our bodies need. If we take no food, we starve; if we take food that lacks some needed substance, after a time we starve just as certainly.

The various articles of food are richer in certain substances than they are in others. As no one article contains all the needed substances in sufficient quantity, we are obliged to take a variety of foods to keep the body in health.

Kinds of Food. — 1. One of the most valuable of all the foods is the *gluten*, or sticky part, of flour. It contains all the substances which the body needs, but not all of them in sufficient quantity.† Nearly the same substances are found in the white of eggs; in the princi-

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* The pupil should here enumerate the different kinds of food in common use, and find out all he can about each. For example: bread is made of wheat; the wheat grows in our fields; the grain is taken to the mill and ground; and the meal or flour is made into bread. This treatment of the subject serves to introduce both farming and manufacturing operations, and to show their relation to our needs.

Again, take rice, another common article of food. This grain is the product of a warm, lowland region. The description of its place and manner of growth serves to show the relations of food to geography, and to give a new and vital interest to that branch of study. In like manner, tea, coffee, sugar, salt, and many other articles may be made to serve a similar purpose.

† Wheat, the most valuable of our grains, contains a large amount of gluten. Fine white flour contains little gluten, and, when we make bread of it, we lose the best part of the grain. The "new-process" flour retains the gluten, and makes excellent bread.

pal part of lean meat; in the curds of which cheese is made; and in the material which forms the *clot*, or thick part, of blood when it is exposed to the air. These foods contain a substance which is necessary for building up the tissues of the body, and because they resemble *albumen* or the substance of which the white of egg is composed, they are called *albuminoids*.

2. Another substance of great value as food is the *starch* that forms a large part of the grains and other vegetable products. Starch does not, however, contain so many of the needed substances as gluten, and is therefore less valuable as food. The same substances in differing proportions are found in *sugar* and in some other articles of food.*

3. The third class of foods includes all oily substances both animal and vegetable, and are known as *fats*. They are composed of the same substances as starch and sugar, but they so differ in form that they need a different treatment before they can nourish the body. The sugars, starches, and fats may be called *heat-making* foods.†

4. *Minerals* form the fourth class of substances that may be ranked as foods. They include lime, soda, potash, iron, salt, and water. These are all in some form found

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* Starch forms a large part of all the grains. Potatoes contain but little besides starch and water. Peas and beans are more than half starch. Tapioca, sago, arrowroot, and rice are nearly all starch. Beets, turnips, and other garden vegetables are principally made up of starch, sugar, and water.

† All the kinds of food given above not only furnish the elements of nutrition, but each helps to furnish the heat necessary for the well-being of the body. But the albuminoids are by far the most important tissue builders, while the sugars, starches, and fats have most heat-producing power. The starchy foods have great power of producing heat, but the fats have still greater. In the frozen regions of the extreme north, oil is one of the most necessary articles of diet.

in the body, and must be contained in the different articles of food. These substances, with the exception of water and salt, are not used separately, but are found in sufficient quantities in meat, in fruit, and in vegetables.

Special Foods. — Of the vegetable foods, wheat flour and oatmeal contain the greatest number of needed elements, and come the nearest to perfect foods. Corn meal is rich in starch and fats, but has little gluten. Peas and beans have a large portion of a substance that resembles gluten, and they are ranked very high as foods. As they are not easily digested, however, they should be taken only in small quantities by those who have weak stomachs.*

Beef is the best of all the kinds of meat. Next to this comes mutton. Chicken and turkey furnish nearly the same materials, with the exception of the fats. Veal, lamb, and pork have less of the substances which the body needs, and are harder to digest. Eggs and milk are nearly perfect foods. Fish and oysters are among the best of foods. Clams, crabs, and lobsters are less easily digested.†

Fruits are mostly made up of starch and sugar, but they also contain more of the mineral matter needed by the system than is found in most other foods. The acid

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* Graham flour, containing the whole of the wheat grain, makes sweet and wholesome bread. Rolls made of this flour, by simply mixing the flour with water or milk, and then pouring the thin batter into a hot roll-pan, and baking in a hot oven, are among the best forms of bread that can be made.

† Meats are best when boiled or roasted. They should be exposed to a hot fire at first, so that a crust may be formed on the outside to preserve the inside juices. In making soups, the meat should be put in cold water, and brought very slowly to the boiling point, so as to extract the juices. When milk produces an unpleasant effect upon the stomach, it should be mixed with a little limewater. Fish and oysters should not be eaten unless perfectly fresh.

of fruits is also an aid to digestion. Fruits are chiefly valued, however, for their agreeable flavors, which gently excite the organs by which the food is made into blood; and when taken in moderate quantities they are very wholesome.*

Mixed Foods. — Our study so far has shown us that no one substance is a perfect food, and therefore that a *mixture of foods* is necessary to properly nourish the body. Experience has taught us the same lesson, and the custom is general of mixing foods in such a way that one will supply what the others lack. Thus bread, rich in gluten, lacks starch or fat, and butter is added; potatoes, mostly starch, are eaten with meat, gravy, or butter.

HOW WE EAT.

Chewing. — The first step toward reducing food to a condition in which it can nourish the body is *chewing*. The organs directly used in chewing are the teeth, the tongue, and the cheeks. The teeth grind the food. The tongue and the cheeks keep the food between the teeth so that it may be ground.

The Teeth. — If we examine the mouth of a cat or a dog, we discover four prominent teeth that are long and pointed. The other teeth, both front and back, are shorter and smaller. These sharp teeth can easily pierce

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* Ripe strawberries, raspberries, blackberries, currants, cherries, peaches, apples, melons, and oranges are all excellent, and their moderate use, each in its season, will, many times, make the doctor's visit unnecessary, and save us from taking medicine.

The pulpy substance of unripe fruits is often hard and tough, and the juice harsh and sour. When fruits, in this condition, are eaten, they can not be digested, and both pulp and juice cause irritation and often inflammation of the stomach and bowels. Unripe fruits may be made wholesome by ripening and by cooking.

soft substances, and seem to be of just the right shape for tearing flesh.

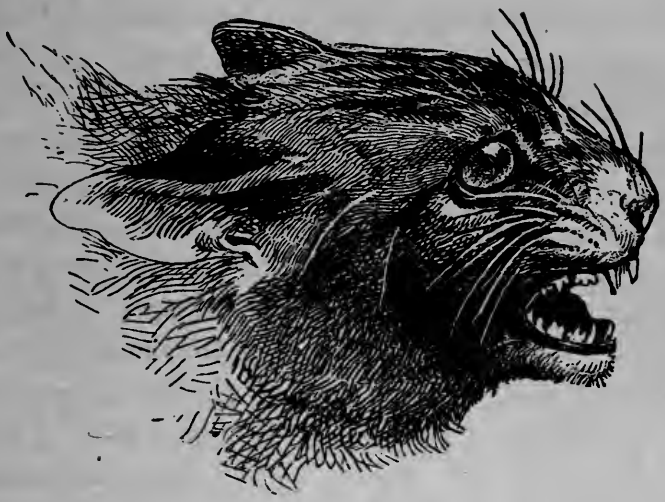

FIG. 4. — A cat "showing its teeth."

In the mouth of a squirrel or rabbit we find the prominent teeth, four in number, directly in front. These teeth are long; but, instead of being pointed, they have a sharp edge like a chisel, which fits them for cutting hard substances or gnawing.

If we look into the mouth of a horse, we find the prominent teeth broad and flat, the exact shape for grinding grain, or for breaking in pieces the soft stalks of plants.

In our own mouths we find teeth like those of the dog, the rabbit, and the horse; but they are all nearly alike in size. There are four *cutting teeth* on each jaw in front; four *pointed teeth*, one on each side of each jaw; eight *teeth having two points*, next to the single-pointed ones; and twelve *back teeth*, six on each jaw.*

* Until children are from five to seven years old, they have only twenty teeth, ten in each jaw. These are called *temporary* or *milk* teeth.

The parts of the teeth that lie inside the bones of the jaw are the *roots*, and the part of each tooth that appears outside the gums is the *crown*. Usually, the back teeth of the upper jaw have three roots each, and those of the lower jaw have two. The others have only one root each.

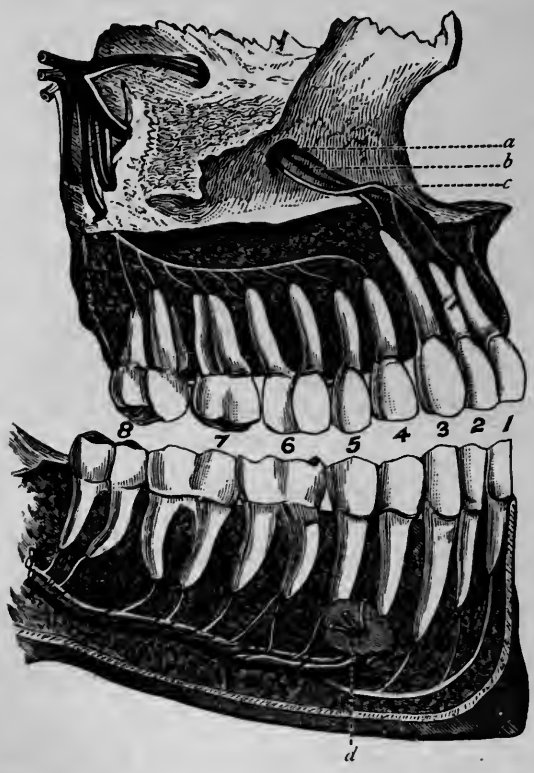

FIG. 5. — The jaws and the teeth: 1, 2, incisors; 3, canine; 4, 5, bicuspids; 6, 7, 8, molars; *a*, vein; *b*, artery; *c*, nerve; *d*, vein, artery, and nerve.

If we carefully examine a tooth, we find that the crown has a hard, smooth outside. This is called the *enamel*. Under the enamel is a softer kind of bone called *dentine*. In the middle of the tooth, and extending to the end of each root, is the *pulp cavity*, through which extend a nerve and a network of blood vessels.

Care of the Teeth. — When the enamel is broken the tooth decays, causing severe pain and an unpleasant breath. To prevent these troubles, the teeth should receive special and constant care.

Some boys try to crack hard nuts with their teeth, but crack the enamel instead, and so spoil their teeth. Biting hard substances of any kind has the same effect. Grinding the teeth together also does harm.

The *pulp*, or soft core of nerve and blood vessels in the pulp cavity, may be injured by great heat or cold, especially sudden changes from very hot or cold food or drink to the opposite — as from ice cream to hot tea.

When food lodges between the teeth and remains there, a kind of acid is formed which destroys the enamel and causes the whole tooth to decay.

How to keep the Teeth Clean. — After each meal, the food lodged between the teeth should be carefully removed by a toothpick of wood or quill. The use of a pin or a penknife is apt to injure the teeth or the gums. On rising in the morning, after each meal, and before going to bed at night, the teeth should be cleaned with water and a toothbrush.* Salt in water, castile soap, tincture of myrrh, or a good tooth powder will help to keep the teeth clean and the breath sweet.

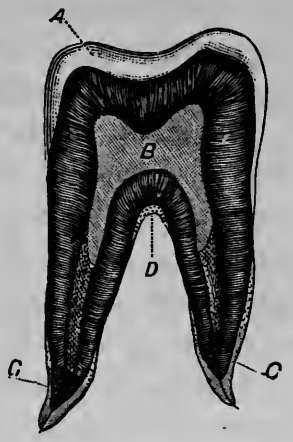

FIG. 6. — Section of a tooth; *A*, enamel; *B*, nerve cavity; *C*, *C*, roots; *D*, dentine.

It is best to have a good dentist examine the teeth once a year, keep them free from the injurious substance called *tartar*, and fill any cavities found. When tartar begins to collect, it may often be removed by scraping the teeth with the broad end of a quill toothpick.

HOW WE SWALLOW.

After the food has been chewed enough, it is to be swallowed. While being chewed, a fluid from the mouth

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* The toothbrush should be stiff enough to remove all food from the teeth, but not so stiff as to injure the gums.

called *saliva* is mixed with it, moistening it so that it can be swallowed easily.

How Saliva flows. — The saliva comes from *glands* near the mouth. These do not pour out saliva all the time, but are excited to action in various ways.

The movement of the jaws will produce a flow of saliva. In chewing, this flow is enough to moisten the food, and in talking it is usually sufficient to keep the mouth moist.

Touching any part of the mouth, or the presence of anything in it, will cause the saliva to flow, as every one knows who has been under the hands of the dentist.

The sight, smell, or taste of food when we are hungry will also "make the mouth water." The same effect may be seen by watching a cow when she is looking on while her supper of turnips is in course of preparation. The saliva is produced in such quantities as to flow out of the corners of her mouth.

Articles of a pungent taste, like mustard, pepper, and horse-radish, make the mouth hot, causing a free flow of saliva.

Amount of Saliva. — We need just enough saliva to moisten our food. When we do not get enough, we find it difficult to swallow, and then there is trouble in the stomach. To get this amount takes time. We need to *eat slowly* and chew our food very fine, so that the movement of the jaws will cause enough saliva to pour out. Bread and vegetable foods need more chewing than meats. Those who eat hastily, and bolt their food without chewing, may look forward to a time when they can not eat with any comfort, and when they will have no strength for work, or play, or enjoyment of any kind.

How Saliva is wasted. — If we keep our jaws in mo-

tion when we are not eating, a useless flow of saliva is produced, which is waste of material and weakening to the body. Chewing gum and all like habits are therefore hurtful.

Tobacco. — One of the most fruitful causes of waste in saliva is the use of tobacco. The pungent qualities of tobacco produce an excessive flow, and, when the exciting cause is constantly kept up, the amount wasted often becomes serious and exhaustive.

Again, by this waste the materials of the blood by which saliva is furnished gradually diminish. The saliva itself becomes weak, inactive, and unable to perform its special work. In this way also other materials needed elsewhere are continually drained off.

One other effect of the use of tobacco needs to be mentioned here. It gives an unpleasant odor to the breath, and often causes a disagreeable habit of spitting; so that clean, sensitive, and refined persons do not like to have those who use tobacco come near them.

Water and the Body. — Water forms about seven parts out of eight of the human body, and ninety-nine parts out of a hundred of the saliva. Water is the principal substance composing some of the most important organs of a healthy body, such as the nerves, the brain, the muscles, and the blood. Even the bones contain water. Water helps to so dissolve the food in the stomach that the blood can carry it as nourishment to each organ. Because every part of the body needs water in order to do its work properly, a certain quantity must every day be taken in the form of food and drink. Whatever disturbs the relation of the right amount of water to the muscles, the nerves, and other portions of the body will injure its health.

Alcohol and Water. — Alcohol has a strong affinity, or

liking, for water.* When taken into the human system, alcohol will quickly unite itself with the water it finds, and taken habitually will make each fluid and tissue less fit to do its own essential work. You will learn more about this fiery liquor in the next chapter.

The Esophagus. — The *esophagus* is the tube through which the food passes from the mouth to the stomach. When the food is sufficiently chewed and moistened, it is pressed backward by the tongue and falls into the portion of the throat lying immediately above the esophagus.

In passing over the entrance to the windpipe the food is kept from falling into it by a *valve*, which shuts down when the food comes along. Sometimes this valve does not close quickly enough, and a particle of food getting into the windpipe chokes us and causes us to cough until it is thrown out. By eating slowly we avoid this danger.

Muscles extend around the esophagus, and when the food enters it they contract, the upper one first, and then the next in order, thus gradually forcing the food into the stomach. The process of eating is now done and stomach digestion begins.

HYGIENE OF EATING.

From the foregoing study of the subject we see that we ought to observe the following rules in regard to eating:

I. Take food that will best nourish the body.

II. Eat slowly, to give the time necessary for preparing the food to enter the stomach.

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* If you place a piece of meat in a dish containing alcohol, in a few hours it will become hard and shrunken. The alcohol has so strong a liking for the water contained in the tissues of the meat that it draws it away from them.

III. Chew food until enough saliva is obtained to moisten it.

IV. Do not injure the teeth by biting hard substances.

V. Avoid exposing the teeth to sudden changes of temperature.

VI. Keep the teeth clean.

VII. Be sparing in the use of highly seasoned foods.

VIII. Do not keep the jaws in motion by chewing gum and other subtances not needed as food.

IX. Avoid the use of tobacco, as it wastes saliva, weakens the body, and makes the person using it disagreeable.

X. Never drink alcoholic liquors, for the alcohol in them makes each fluid and tissue of the body less fit to do its work.

SOMETHING TO FIND OUT.

1. What other grains besides wheat are raised on our farms?

2. What garden vegetables do we raise to eat?

3. What part of the corn plant do we eat? of the potato plant? of the beet? of the onion? of asparagus? of cabbage?

4. What substance in dough makes it stick together?

5. How is wheat bread made light?

6. Why is it more difficult to make corn bread light? In making corn bread, what is the effect of mixing the white of eggs with the corn meal?

7. Why is fat meat eaten more in winter than in summer?

8. How is the oil necessary for food obtained in the frozen regions?

9. Why is more wholesome food made from Graham flour than from fine white flour?

10. Why is beef as a food better than pork?

11. Why are oysters better than clams?

12. Why is it better to roast beef than to boil it?

13. In boiling meats, should they be put into cold or hot water at first?

14. In what condition should oysters and fish be when used for food?

15. Of what benefit is the acid of fruits?

16. Why are green fruits unwholesome?

17. How may green fruits be made wholesome?

18. What kind of food should be mixed with the albuminoids? What with the starchy foods?

19. In cooking, what is usually mixed with macaroni? Why?

20. Mention other foods that are usually eaten together.

21. What are milk teeth, and what care do they need?

22. When the permanent teeth show signs of decay, what should we do?

23. Why should we be sparing in the use of mustard and horse-radish?

24. When people know that the use of tobacco is hurtful, why do they not leave it off?

25. What is the best way to avoid the trouble of leaving off the use of tobacco?

26. How much of the body is water?

27. Why must a certain quantity of water be taken every day in our food or drink?

28. What will be the result of depriving any tissue of its proper amount of water?

29. What relation exists between alcohol and water?

30. How does alcohol act when taken into the human system?

31. What effect does this have upon the tissues?

32. What evils follow from eating too rapidly?

TOPICAL ANALYSIS OF CHAPTER II.

EATING, AND WHAT COMES OF IT.

Why we eat.

1. The body always wearing out.
2. It needs repair.
3. We eat to live.
4. We eat to do the work we have to do.

What we eat.

1. Different elements needed.
2. Food related to the industries.
3. Food related to geography.
4. Kinds of food.
   1. Albuminoids: gluten — white of eggs — fibrine of blood — cheese.
   2. Sugars and starches.
   3. Fats: animal and vegetable oils.
   4. Minerals: lime — soda — potash — iron — salt — water.
5. Special foods: vegetables — meats — fruits.
6. Value of different foods.
7. Ways of cooking.
8. Mixed foods necessary.

How we eat.

1. Chewing.
2. The teeth: structure — names — uses.
3. Care of the teeth: necessity — implements.

How we swallow.

1. How saliva flows — exciting causes.
2. Amount of saliva.
3. How saliva is wasted.
4. Tobacco: wastes saliva — vitiates saliva — defiles the breath.
5. Water in the body: abundance — importance.
6. Affinity of alcohol for water.
7. The esophagus: structure — action.

Hygiene of eating.

Something to find out.

CHAPTER III.

Alcohol and its Effects.

THE NATURE OF ALCOHOL.

Decay a Law of Nature. — It is a law of nature that all that lives must die, and all that dies must decay or go to pieces, in order that the substances of which it is composed may be set free to make new forms of life. All plants and fruits are composed of certain elements which were once a part of the earth, air, and water. Therefore, when a plant dies, or a fruit is fully ripe, it decays or falls to pieces, and the materials composing it are set free to make up new fruits and plants.

What causes Decay. — Fruits and plants do not decay of themselves, but their decay is the work of minute living forms,* which cause them to change and go to pieces.

There are many kinds of these called by various names, and each doing a different kind of work. Although too small to be seen by the naked eye, the microscope has shown that they, or the tiny germs or seeds that produce them, float in the air ready to attack any substance they can work upon. Those of one kind are the *molds*. You

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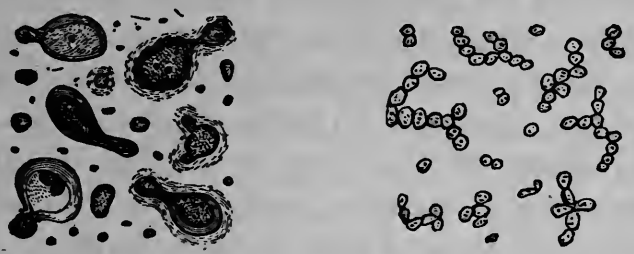
* These minute living forms are in reality plants. The mold of leather, dried fruit, bread, and cheese, mildew, and other forms of mold that cause fruits to rot, all belong to this class of plants, called *fungi*. (See article on "Fungi" in Appletons' "American Cyclopædia.")

have seen mold on cheese, bread, and other things, and know how soon it will spoil what before was good food.

Ferments and what they do. — Others of these minute living forms are the *ferments* that cause *fermentation*, or decay, in sweet liquids.*



Magnified 2000 diameters. Magnified 250 diameters.

FIG. 7. — Ferments illustrated by yeast cells.

It is these ferments that turn the juices of good fruit and grain into alcoholic liquors. They can not do this if the juice is in the whole or unbroken fruit,† but when

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* These ferments are one-celled plants which multiply themselves by budding. The buds before fully grown are called *spores*. In sweet liquids they live singly or in united bud colonies, where they multiply rapidly and excite fermentation. (See "Bacteria and Yeast Fungi," by W. B. Grove, B. A., of the Birmingham Natural History and Microscopical Society, Eng., p. 57.) Ferments fasten in an inactive state on the skin of fruit, by which means they are introduced into its juice when squeezed out to be fermented. The spores are transported through the air until they rest on the downy surface of fruit or berry. It has been asked what becomes of these ferments between last year's vintage and the succeeding summer, and in what way they pass the winter. According to Hansen's researches they are washed off from the fruit by the rain, dispersed by the wind, and fall to the ground with the fruit, where they remain through the winter as dormant spores, ready to return to the fruit of the same plant when it has ripened in summer. (Trouessart's "Microbes, Spores, and Ferments," p. 77.)

† It is not these ferments, but germs of another kind, that cause apples and other fruit to decay. (Trouessart's "Microbes, Spores, and Ferments," p. 46.)

it is pressed out and left exposed to a moderately warm air these ferments do their work.

Some plants, as sugar cane and maple, are sweet because there is sugar in their juices. This sugar is obtained in a dry state by boiling off the water. Maple sugar and the sugar used for food and for making candy are made in this way. Many fruits, as apples, grapes, and berries, are more or less sweet because sugar is formed in them as they ripen. When such fruits are crushed and their juices are drawn off, the sugar is the part of the juice that first begins to decay, or go to pieces. As we have said, it does not decay of itself. These ferments or their germs from the air, or from the stems and surfaces of the fruit,* easily pass into this juice, and if it is moderately warm and sweet, each ferment will soon produce a large number of other ferments like itself.†

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* M. Louis Pasteur, in his "Studies on Fermentation," pp. 152–157, describes an experiment by which he was able to examine with a microscope the germs of ferments and molds which gather upon the stems and surface of fruits. He cut off a cluster of fine grapes with a pair of scissors that had been passed through a flame to destroy all germs that might be clinging to them, wrapped them in a piece of paper that had been slightly scorched for the same purpose, and carried it very carefully to his laboratory. Here the grapes were washed in some distilled water, perfectly free from dust or germs, and the water examined with a microscope. It was found to contain many little organized bodies consisting chiefly of simple, transparent, colorless cells. Some of larger size had a yellowish-brown color, and were detached. Others were united in irregular masses.

Other fruits were examined in the same way with similar results. Some of these cells M. Pasteur put into fresh grape juice which had been heated so as to kill all the germs of ferments it before contained, whereupon these ferments began to bud in it, and produce alcoholic fermentation.

† On October 12, 1881, at 10 o'clock in the morning, we crushed some grapes, without filtering the juice that ran from them; afterward, at different times during the day, we examined the juice under

As these ferments increase in number they change the sugar of the liquid into two other substances. It is then no longer sugar, but a gas,* and a poisonous liquor called *alcohol.* The gas may be seen rising in bubbles through the liquid. It escapes into the air at the top, but the alcohol remains in the liquid.

Alcohol not like Water. — The alcohol that thus forms in fruit, grain, and vegetable juices is a clear, colorless fluid. As you will soon learn, it can be separated from the rest of the liquid, and is then found to look like water, but its nature is not at all like water. Water will neither burn of itself, nor will it burn those who drink it. If alcohol is touched with a lighted match, it will burn as easily as kerosene oil. Water satisfies thirst. Alcohol creates an almost uncontrollable thirst.

What is a Poison? — A substance whose nature it is when absorbed into the blood to injure health or destroy life is a *poison.* The rapidity with which a poison acts depends upon the quantity taken.

Alcohol a Poison. — The nature of alcohol is that of a

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the microscope, until at last, although not before 7 o'clock in the evening, we detected a couple of cells. From that time we kept these contiguous cells constantly in view. At 7.10 we saw them separate, and remove to some little distance from each other. Between 7 and 7.30 we saw on each of these cells a very minute bud originate and grow, little by little. At 7.45 the buds had increased greatly in size. By 8 o'clock they had attained the size of the mother cells. By 9 each cell of each couple had put forth a new bud. We did not follow the multiplication of the cells any further, having seen that in the course of two hours two cellules had furnished eight, including the two mother cells. An increase like this, which would have been more rapid at a higher temperature, may indeed seem surprising. It is really, however, nothing to what sometimes occurs. (Pasteur's "Studies on Fermentation.")

* *Carbonic-acid gas*, or *carbon dioxide*, the gas used in charging soda fountains.

poison. When taken in small quantities it acts injuriously upon the nerves and other important parts of the body. If taken in this way continuously, it acts as a slow poison. When taken in sufficiently large quantities it is capable of causing death in a few hours. In a few cases it has done so in less than an hour.* Every drunken man may be considered a case of poisoning by alcohol. Because alcohol especially affects the brain it is called a *brain poison*, and through its influence on that organ it is capable of greatly *changing and finally ruining the character.*

Alcohol a Narcotic Poison. — Any drug that benumbs, that takes away the sense, that deadens or causes stupor, is called a *narcotic.*† Because alcohol does this through its effect upon the nerves and brain it is classed as a *narcotic poison.*

THE EFFECTS OF ALCOHOL.

The Moderate Drinker. — It is often urged that men have been known to drink alcoholic liquors a long time and yet live. A great English physician ‡ said concerning this: "The stomach and other organs of the body

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* Dr. Alfred S. Taylor tells of "a man who died in half an hour after swallowing a bottle of gin for a wager, although a large quantity of the spirit had been in the meantime removed by a stomach pump." (Taylor's "Treatise on Poisons," p. 610.)

† A primary stage of stimulation sometimes precedes the true narcotic effect, but much of what is called stimulation, as for instance the noisiness or restlessness of alcohol, is in reality the beginning of narcotism, being due to a gradual removal of the restraints imposed by the higher faculties, by custom, or by timidity, upon the lower impulses. In the later stages of narcotism the faculties of sensation, of voluntary and reflex motion, are abolished, and death may result from paralysis of the centers that govern the circulation and respiration. Familiar examples of this class of drugs are opium, alcohol, and chloroform. ("American Cyclopædia," article, "Narcotics.")

‡ Dr. B. W. Richardson, "Diseases of Modern Life," p. 236.

may be so hardened and changed by alcohol that it may seem to fit them for a long time, but the alcohol will all the while be silently doing its fatal work."

Such a drinker is less of a man or woman in both health and character because of this poison, which one person may be able to bear longer than another.

The Alcoholic Appetite. — We have seen that a little alcohol taken at frequent intervals affects the drinker as a slow poison; and that in large quantities taken at one time it will speedily destroy life. But one of its most dangerous characteristics is the fascinating power that a little alcohol has, in such liquors as beer, wine, and cider, to create a craving desire for more alcohol.

The drinker does not at first seem to realize his danger; but the more he takes of this poison the more he cares for it, and the less he cares about doing right. As he keeps on, the time comes when anything may be sacrificed for this selfish gratification of the appetite which he seems to have no power to resist. The alcoholic appetite once fastened upon a person persistently clings to its victim. After being long resisted it may be roused to redoubled fury by a slight taste, or even smell, of an alcoholic liquor.

The nature of alcohol is not changed by its being put into food. A little there, as anywhere else, has the power to rouse an appetite for more. The only safe course for a person who has an alcoholic appetite is to at once and forever refuse to take any form of alcohol.

HYGIENE.

I. Decay changes the nature of any substance, making what was before good unfit for its previous uses. Molds are the cause of one form of decay. Therefore we should not eat moldy bread, fruit, or moldy food of any kind.

II. Ferments and yeast cause a fermentation or decay in some sweet liquids. They turn the sugar in these to alcohol. We should never drink liquors that contain alcohol, because alcohol is a poison.

III. Pure water and good milk are the natural and healthful drinks. We may safely take them to quench our thirst.

IV. Because alcohol is a narcotic poison, and takes away the sense and makes those who use it stupid, is another reason why we should never drink anything that contains it.

V. It is not safe for us to take a little alcohol, because it is the nature of a little alcohol to create a craving desire for more alcohol, and the more one drinks the more he wants, until alcohol finally destroys him.

VI. The use of wine, brandy, cider, or any alcoholic liquor in flavoring jellies, pudding sauces, pies, or any form of food is dangerous, especially to those who have a taste or craving for alcohol.

SOMETHING TO FIND OUT.

1. What is the great law of nature in regard to decay?
2. What reason can you give for this?
3. Of what were the substances composing all plants and fruits once a part?
4. What becomes of these substances when the fruit or plant dies?
5. What causes fruit and plants to decay?
6. What can you tell of the various kinds of these living forms?
7. What can you tell of their size?
8. What has the microscope shown concerning them?
9. What name is given to one kind of these living forms?

10. Where are they often seen?

11. How do they affect articles of food?

12. What name is given to another kind of minute living forms?

13. In what do they cause decay?

14. What do these ferments do to good fruit and grain juices?

15. What can you say of the ferments and the juice while it is in the fruit?

16. Do the ferments change the sugar in fruit juices to alcohol while it is in the fruit?

17. How do we know that the juices of some plants contain sugar?

18. Why are such fruits as apples, grapes, and berries sweet?

19. What part of fruit juice first begins to decay after it is pressed out from the fruit?

20. What causes this decay?

21. How do the ferments get into the fruit juices?

22. If the juice is moderately warm and sweet, what will each ferment do?

23. As the ferments increase, how do they affect the sugar of the liquid?

24. What new substances are thus produced?

25. Tell what you can of the gas thus formed; also of the alcohol.

26. What is the appearance of the alcohol formed in fruit, grain, and vegetable juices?

27. In what respect does it differ from water?

28. Which will quench thirst?

29. Which will create it?

30. What effect will a lighted match have upon alcohol?

31. What is a poison?

32. Upon what does the rapidity with which a poison acts depend?

33. What is the nature of alcohol?

34. How does it act when taken in small quantities?

35. What kind of a poison may it then be called?

36. What effect may follow taking large quantities of alcohol?

37. What may every drunken man be considered?

38. Why is alcohol called a brain poison?

39. What is likely to be the effect of alcohol upon the character?

40. What is a narcotic?

41. Why is alcohol a narcotic?

42. What two important facts have you learned concerning alcohol?

43. What is one of the most dangerous characteristics of alcohol?

44. What can you say of the drinker in regard to this danger?

45. What is his condition as he takes more and more of the poison?

46. What shows the strength that the appetite for alcoholic drinks may come to have?

47. When the alcoholic appetite has once fastened upon an individual what is the usual result?

48. How may such an appetite when long resisted be again roused?

49. What does this teach in regard to flavoring articles of food with wine, brandy, or other alcoholic liquors?

50. What is true of the nature of the alcohol thus used?

51. What has it still the power to do?

52. How can the alcoholic appetite be conquered?

53. What is the best way to avoid all these evils?

TOPICAL ANALYSIS OF CHAPTER III.

ALCOHOL AND ITS EFFECTS.

Nature of Alcohol.

1. Decay necessary to new forms of life.
2. Decay the work of minute living forms.
3. Action of ferments.
    1. Hastened by warmth.
    2. Sugar in juices first acted upon.
    3. Sugar separated into alcohol and gas.
4. Alcohol: clear — colorless — burns — creates thirst.
5. A poison, absorbed into the blood, injures or destroys life.
6. Alcohol a poison.
    1. In small quantities a slow poison.
    2. In large quantities a deadly poison.
    3. A brain poison.
    4. A narcotic poison.

Effects of Alcohol.

1. Moderate drinking injurious.
2. The alcoholic appetite.
    1. Fascinating power of alcohol.
    2. A little creates a desire for more.
    3. At last overpowering.
    4. May be roused by alcohol in food.
    5. Abstinence the only safety.

Hygiene.

Something to find out.

CHAPTER IV.

Alcoholic Drinks and Tobacco.

CLEAR alcohol is so strong and fiery that few persons care to drink it. The harm that comes from the use of this poison is chiefly caused by beginning with liquors that contain some alcohol with more water.

DRINKS CONTAINING ALCOHOL.

Cider is a drink made from the juice of apples. This juice is largely composed of water that is more or less sweet, with a peculiar apple flavor. There is no alcohol in it while it is still in the unbroken apple. But ferment germs that float in the air, or that may be resting on the stem or skin of the apple, enter the juice as it is squeezed out. Very soon little bubbles may be seen rising in this juice. These bubbles are the gas * that is always formed, with alcohol, when ferments cause the sugar in such a fluid to decay. This gas bubbles up through the cider and goes off into the air, but the alcohol remains in the cider. As alcohol is a poison it makes cider a poisonous drink.

If the weather is moderately warm, alcohol will appear in apple juice in about six hours after it has been pressed out, and sometimes sooner. The mill is often wet with the juice left from another day's grinding, in which ferments have begun to work. This will act as yeast

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* Carbonic-acid gas (*carbon dioxide*).

to hasten fermentation and the earlier appearance of alcohol in the next cider that is made.

Effects of Cider Drinking. — The quantity of alcohol in a given amount of cider is constantly increasing from the time when the ferments first began to change the sugar of the apple juice until they have finished their work. Such cider is said to be growing "hard." "Hard cider" sometimes contains one part of alcohol to ten parts of cider. A person who begins to drink from a barrel of cider when it is sweet, and continues to do so until it becomes hard, gets every day a little more of the dangerous poison, whose nature it is to make those who use it wish to drink more and still more. Some of the worst drunkards learned at the cider barrel the liking for alcohol that led them on to ruin. The narcotic power of alcohol, even in cider, is capable of so deadening right feelings and taking away the sense, that cider drinkers are likely to be cross and ugly tempered. Cider in any quantity is a dangerous liquor, and should not be drunk.

Wine is made from grapes. The grape is a delicious and healthful fruit, more or less sweet, with no alcohol in its juice while in the grape. But here, as in the case of the apple, the ferments in the air and those gathered upon the surface of the fruit easily pass into the grape juice that has been pressed out. If the air is moderately warm they quickly begin to work upon the sugar, causing it to turn into carbonic-acid gas and alcohol. The gas passes out of the liquid in small bubbles, but the alcohol remains in the wine to work injury upon all who drink it.

Homemade Wines, put up by the housewife, made from currants, elderberries, or other fruits, are as dangerous as any. Ferments turn the sweet principle, or sugar, in such juices into alcohol and gas just as they do in wine made on a larger scale. If — as is often the case — a

small amount of sugar is added to these juices when they are left to ferment, the wine will be more poisonous, as there will be so much more sugar to be turned to alcohol.

Wine and Drunkenness. — It was once thought that if people would use "light wines" — that is, wines like claret, which contain only a small quantity of alcohol — they would not want the stronger liquors, and there would be less intemperance. But that does not prove to be true.

It is the nature of alcohol in wine, cider, or any such liquor to create a craving desire, not only for more wine, but for stronger drinks. At the same time the narcotic effect of the alcohol deadens the sense of right that should restrain the drinker from indulging this perilous appetite. Therefore wine drinking tends to greatly increase rather than to lessen drunkenness.*

How can we prove that there is Alcohol in Cider or Wine? — Put a long, close-fitting pipe into the cover of a vessel containing cider or wine, and place the vessel over a lighted lamp. In a short time, and before the cider boils, a vapor will rise from the liquid and pass into the pipe. Because alcohol turns to vapor with less heat than water this vapor will consist chiefly of alcohol. If the pipe be now laid across a piece of ice, the vapor passing through it will condense into a liquid again and collect in drops at the farther end of the pipe, where a vessel may be placed to receive it. The first few drops of liquid so collected will consist almost entirely of alcohol,

* Rev. A. L. Stone, D. D., after spending some years in California, said: "I had entertained a sort of hope that the manufacture of pure wines and their introduction into general use would crowd out the gross strong liquors, and diminish intemperance. I am now fully convinced that this hope was groundless and delusive. It appears that in wine-growing districts intemperance is on the increase, extending even to the youth of both sexes." Like testimony is reported from France, Persia, and other countries where wine is extensively manufactured.

the water with which it was mixed being nearly all left behind in the vessel over the lamp. If the liquid is allowed to boil, the water will also turn to vapor, and passing through the pipe it will collect in drops and mix again with the alcohol.

Beer is a fermented drink made from barley or other grain. Grains, unlike fruits, contain no sweet juices to be changed to alcohol. They are composed mostly of starch. The brewer moistens the grain and keeps it warm for a little while, and this turns the starch to sugar. Then he dries it to prevent further sprouting. This sprouted grain when dried is called *malt*. It is ground or mashed, and water is added to dissolve out the sugar (*glucose*), when it becomes a sweet liquid that can be fermented.

The ordinary brewer does not wait for the ferments from the air to find their way into this liquid, but supplies them by adding *yeast*, which is one kind of ferment. The yeast works upon the sugar in the grain juice as the ferments do upon that in the fruit juices, in turning it to carbonic-acid gas and alcohol. The gas passes off into the air, and the alcohol remains in the beer, making it a poisonous liquor.

Thus grain, which was once good food, is changed into a poison. The beer drinker is not likely to be long satisfied with a little beer, for it is the nature of the alcohol in beer, as in cider and wine, not only to do direct harm, but to create a craving for more.

The use of beer injures the health and lessens the strength of the body and weakens the higher faculties of the mind. It tends to make the drinker selfish, cruel, and brutal, while it stupefies the reason and judgment.

Homemade Beer. — Herbs, barks, and roots are sometimes steeped in water, and sugar and yeast added, to make "domestic" beer. Fermentation soon follows. The

sugar turns to gas that passes off into the air and to alcohol that remains in the liquor. The presence of alcohol always makes any liquor a dangerous drink.

EFFECTS OF FERMENTATION.

Why Fermentation makes Good Bread and Poisonous Beer. — The yeast which the cook uses in making bread is one kind of ferment. In the flour is a very small quantity of free sugar. When the flour is moistened and kept warm, this sugar is acted upon by the ferments of the yeast, and changed into carbonic-acid gas and alcohol. As the gas forces itself out through the dough it makes little spaces or holes, which remain after the bread is baked, and we say the bread is "light."

Alcohol does not stay in the bread, as it does in beer, cider, and wine, to create an appetite for more alcohol; it is turned to vapor by the heat as the bread is baking, and passes off in the oven. There is no alcohol in well-baked bread. The fact that alcohol remains in the beer, but not in the bread, explains why beer is a poisonous liquor while bread is a healthful food.

Fermentation changes the Nature of Substances. — Ferments, you remember, change the sugar in sweet fruit juices, which are wholesome and healthful, to alcohol, which is a poison. But if these changed juices, that are now cider or wine, are allowed to stand in a warm place open to the air, another kind of ferment enters the liquid and causes another change. This time the alcohol, the result of the first fermentation, is changed and becomes a sharp acid (*acetic acid*). Wine or cider thus affected is no longer wine or cider, but another substance, called *vinegar*. There is no alcohol in vinegar. The nature of vinegar is very different from that of a liquor containing alcohol. If a person uses a little vinegar to flavor

food, he is in no danger of forming an appetite that will make him want to drink more and more vinegar every day. Lemon or lime juice is a more healthful acid than vinegar.

Vinous and Acetous Fermentation. — There are several kinds of fermentation.

Vinous fermentation is that which changes the sugar of sweet juices to alcohol. *Acetous fermentation* changes alcohol and other substances into vinegar.

What we have observed of these two kinds of fermentation is true of all, viz., that fermentation changes the nature of the substance it works upon.

A Serious Mistake. — Once people did not know this fact. They thought that because grain and fruit are good for food, the wine, cider, and other liquors made from them must be good also. But this is not true, and is a mistake that has led many to ruin. The nature of the grain and fruit substances from which beer, wine, and cider are made is entirely changed by fermentation; the sugar in these, which was once a food, is turned into a treacherous and enticing poison.

DISTILLED LIQUORS.

The habit, as you have learned, of drinking wine, beer, or cider usually leads to a desire for liquors that contain more alcohol.

Distillation. — To obtain such, the alcohol in cider, wine, etc., is separated from a portion of the water which makes up a large part of these liquids. The process by which this is done is called *distillation*. *Brandy* is a liquor distilled from wine. *Rum* is distilled from the fermented juice of sugar cane. *Whisky* is distilled from fermented liquids made from corn or other grains, sometimes from potatoes.

Effects of Distilled Liquors. — Such liquors are usually about one half alcohol, and are therefore capable of doing rapid and great damage to those who use them. While the craving thirst for more alcohol is growing with its indulgence, the strength of the drinker's will is being weakened by the effect of the alcohol. He then finds it very hard to resist the use of the poisonous drams that only increase the thirst and shorten the road to ruin. To stop drinking every form of alcohol at once and forever is his only chance to escape the drunkard's fate.

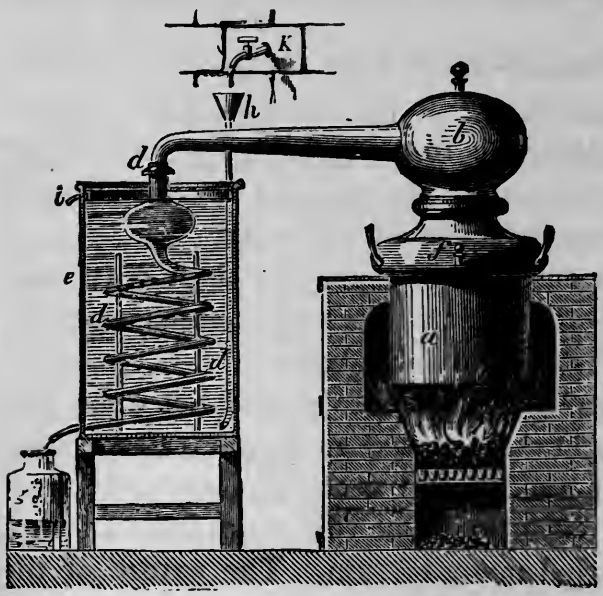

FIG. 8. — A still. *a*, *f*, *b*, *c*, *d*, retort in which the liquid is changed to vapor; *d*, *d*, worm; *K*, *h*, *e*, *i*, cooler and arrangements for condensing the vapor in the worm.

TOBACCO.

The tobacco plant is a native of the United States. Its broad, pale-green leaves when dried are used for chewing, smoking, and snuff.

Nicotine. — Tobacco contains a sharp, biting, oily liquid called *nicotine*, which is a powerful *brain and heart poison*. Nicotine dissolves freely in the saliva and is then absorbed. Therefore chewing is one of the most injurious forms of the tobacco habit.

Cigarettes do a great amount of mischief. There is

abundant evidence that boys and young men are now being greatly injured by the use of tobacco in this form. No person who is in training for rowing or any other test of strength or physical skill is allowed to use tobacco in any way.

"In an experimental observation of thirty-eight boys, of all classes of society and of average health, who had been using tobacco for periods ranging from two months to two years, twenty-seven showed severe injury to the constitution and insufficient growth; thirty-two showed the existence of irregularity of the heart's action, disordered stomachs, cough, and a craving for alcohol; thirteen had intermittence of the pulse; and one had consumption. After they had abandoned the use of tobacco, within six months' time one half were free from all their former symptoms, and the remainder had recovered by the end of the year." *

HYGIENE.

Ferments will ordinarily begin to turn the sugar in apple juice to alcohol in about six hours after it has been squeezed out, and sometimes sooner.

I. We should not drink cider, because it is the nature of the alcohol in cider to create an appetite for more alcohol.

II. Cider deadens the sense and tends to make its drinkers ill-tempered and careless about doing right.

III. We should get our grape juice by eating the healthful and delicious grapes.

IV. When the grape juice has been squeezed out and its sugar turned to alcohol, it is a poisonous drink, and we should not take it.

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* C. W. Lyman, in "New York Medical Journal," September 8, 1888.

V. Homemade wines, if produced by fermentation, are unsafe drinks because they contain alcohol.

VI. It is the nature of alcohol in even the weakest wines to create an appetite for more alcohol. Thus wine tends to increase intemperance rather than to decrease it, as some have supposed.

VII. Fermentation is a part of the process of making bread, but the alcohol is all evaporated out of well-baked bread. We should not eat bread that is not well baked. It is not digestible.

VIII. Beer, like other alcoholic liquors, tends to debase the morals and make the drinker brutal.

IX. Homemade beers produced by fermentation contain alcohol. We should not drink beer of any kind.

X. There is no alcohol in vinegar. We may safely flavor our food with it. Lemons and limes furnish more healthful acids than vinegar.

XI. Fermentation entirely changes the character of anything it works upon. The germs that cause stewed fruit and preserves to ferment are not the alcoholic ferments, but they spoil the stewed fruit or preserves, and make them unfit for us to eat.

XII. The habit of chewing tobacco is not only disgusting, but very injurious, as the poison of the tobacco, the nicotine, is dissolved in the saliva and absorbed by the system.

XIII. The use of cigarettes by young boys weakens the muscles and hinders growth, besides causing other serious injuries. The healthy body does not require tobacco in any form and it should never be used.

SOMETHING TO FIND OUT.

1. What is cider?
2. Of what is it largely composed?

3. When is there no alcohol in apple juice?

4. What enters the juice when it is squeezed out?

5. How may we know when the ferments are at work in the apple juice?

6. What are the rising bubbles? What becomes of this gas?

7. What becomes of the alcohol?

8. How does this affect the cider?

9. How soon after apple juice is pressed out is alcohol present in it?

10. What may hasten the formation of alcohol in apple juice?

11. How does the amount of alcohol in cider vary as the ferments keep at work?

12. What is then said of the cider?

13. How much alcohol may hard cider contain?

14. Under what circumstances will a person drinking the same quantity of cider every day get an increasing amount of alcohol?

15. What is it the nature of this alcohol to do?

16. Where have many drunkards learned their liking for alcohol? To what has it led them?

17. What is the alcohol in cider capable of doing?

18. From what is wine made?

19. What can you tell of the grape?

20. What is true of its juice while in the grape?

21. What happens when the juice is squeezed out?

22. What change is made in it by these ferments?

23. What remains in the wine?

24. What is the alcohol capable of doing?

25. Why are homemade wines dangerous?

26. How does alcohol get in them?

27. What will be the effect of adding a little sugar to the juice from which these wines are made?

28. What are "light wines"? Why do they lead to intemperance?

29. How does the narcotic effect of alcohol increase the liability to drunkenness?

30. Describe a simple process of separating the alcohol in cider or wine from the rest of the liquid.

31. How may the alcohol be collected?

32. What does this prove concerning cider and wine?

33. How do grains differ from fruits in regard to juices?

34. Of what are grains mostly composed?

35. How does the brewer make the starch sweet?

36. When is the brewer's grain called malt?

37. How is a sweet liquid obtained from this?

38. How does the brewer make this liquid ferment?

39. How does yeast affect grain juices?

40. How does the alcohol affect the beer?

41. What change is thus made?

42. Why does the beer drinker soon want more beer?

43. What effect has beer drinking on health and strength? What effect has it on the mind?

44. How does it affect the character?

45. How are homemade beers sometimes made?

46. What becomes of the sugar in such liquids?

47. Why are these homemade beers dangerous drinks?

48. What is the yeast used in making bread?

49. What is there in the flour upon which the ferments can work? Into what is it changed by the yeast?

50. What makes bread light?

51. What becomes of the alcohol formed in dough?

52. Why is bread healthful, though alcoholic liquors made from the same kind of grain are poisonous?

53. What happens when cider or wine is allowed to stand in a warm place open to the air?

54. What part of the cider or wine is changed?

55. What is the liquid called which is produced by these other ferments? Does vinegar contain alcohol?

56. What can you tell of the nature of vinegar?

57. What fact shows the difference between vinegar and a liquor containing alcohol?

58. What acids are more healthful than vinegar?

59. What is vinous fermentation?

60. What is acetous fermentation?

61. What is the effect of all fermentation?

62. What mistakes have people made concerning alcoholic liquors made from fruits and grains?

63. What has been the result of this mistake?

64. What effect has fermentation on the nature of grain and fruit substances?

65. What is the character of this change?

66. To what do habits of drinking wine and beer usually lead?

67. How are strong alcoholic liquors obtained?

68. What is this process called?

69. What liquor is distilled from wine?

70. What from the fermented juice of sugar cane?

71. What from fermented liquids made from corn, other grains, or potatoes?

72. What is the usual proportion of alcohol in such liquors?

73. What can you say of their power to harm?

74. Why is it so difficult for the habitual drinker to leave off his dram?

75. How may he escape being a drunkard?

76. What is tobacco?

77. In what ways is it used?

78. What poison is contained in tobacco?

79. Why is chewing one of the most injurious forms of the tobacco habit?

80. What is the objection to cigarette smoking?

81. Mention some facts showing the injurious effects of cigarette smoking upon young persons.

TOPICAL ANALYSIS OF CHAPTER IV.

Alcoholic Drinks and Tobacco.

Drinks containing Alcohol.

1. Cider.
   1. Made from apples.
   2. No alcohol in the unbroken apple.
   3. Its sugar changed to alcohol and gas by ferments.
   4. Injurious effects of cider.
   5. Unsafe to drink cider as it grows "hard."
2. Wine.
   1. Made from grapes.
   2. Grape juice turned to alcohol by ferments.
   3. Homemade wines also dangerous.
   4. "Light" wines increase drunkenness.
3. Proof that there is alcohol in cider or wine.
4. Beer.
   1. Made from barley or other grain.
   2. Starch turned to sugar and sugar to alcohol.
   3. Harm of drinking beer.
   4. Danger from homemade beer.

Effects of Fermentation.

1. Makes good bread and poisonous beer.
2. Changes the nature of substances.
3. Vinous and acetous.
4. Acetous fermentation does not produce alcohol.
5. A serious mistake.

Distilled Liquors.

1. Distillation.
2. Brandy distilled from wine.
3. Rum distilled from juice of sugar cane.
4. Whisky distilled from liquids made from corn and other grains and potatoes.
5. Effects of distilled liquors.

Tobacco.

1. Nicotine.
2. Cigarettes and their effects.

Hygiene.

Something to find out.

CHAPTER V.

How Digestion goes on.

To nourish the body, the food we eat must be converted into blood. A part of the work of *digestion*, or of preparing food to enter the blood, takes place in the stomach. For this reason the stomach is one of the most important organs of the body. Any part of the body that has some special work to do is called an *organ*.

STOMACH DIGESTION.

Structure of the Stomach. — The *stomach* is a sack or bag in the lower cavity of the body, and holds from one to two quarts.* It has two openings. Through the *upper opening*, the food comes in from the esophagus; and through the *lower opening*, the food, when in a proper condition, passes out into the intestines.

FIG. 9. — The stomach.

* The trunk has two cavities, the *chest* and the *abdomen*. These cavities are separated by a thick, muscular membrane, called the *diaphragm*.

The stomach is made up of three coats. The *outer coat* is strong and smooth. Its glossy surface is moistened by a fluid so that when it rubs against the walls of the trunk, or against any of the other organs, there is no friction.

The *middle coat* is made up of muscles, which extend around the stomach in both the longest and the shortest ways. These muscles contract and expand, giving motion to the stomach and churning its contents.

The *inner coat* is soft, and lies in little ridges or folds, giving a great amount of surface. It has in it many little sacs or *glands*. These glands separate from the blood a fluid called *gastric juice*, an important fluid in the work of digestion. When food is taken into the stomach these glands pour out their contents upon it. The churning process brings the gastric juice into contact with the food, and thoroughly mixes the contents of the stomach.

Food Changes. — The saliva, mixed with the food, helps to change starchy foods, such as rice and potatoes, into a kind of sugar. This process is necessary to fit this class of foods to enter the blood.

The gastric juice dissolves such foods as the white of eggs, the gluten of grain, and the solid part of meat, and makes them fit to enter the blood.

A small portion of the food thus dissolved soaks through the walls of the stomach into very small blood vessels, and through them passes into a large vein, called the *portal vein.** But by far the greater part is con-

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This membrane is attached to the walls of the trunk, and forms the floor of the chest and the roof of the abdomen.

* The portal vein is formed by the veins from the intestines, spleen, pancreas, and stomach, and passes into the liver by two branches. Thus all the blood from the digestive organs passes through the liver before entering the general circulation.

verted into a slimy, fluid mass, called *chyme*, and passes out of the stomach through the lower opening.

Drink.— At each meal, no more drink should be taken with the solid food than is sufficient to moisten the mass in the stomach. If too much is taken, the gastric juice is so diluted and weakened that it can not properly perform its work.

If the stomach and its contents become too cool, its inner and muscular coats will not act properly in dissolving and churning the food into a fluid, neither will the small veins take up the food as they should and send it on to the portal vein. By drinking ice water, or any very cold drinks, with our meals, the heat of the stomach is diminished, and the work of digestion goes on slowly, or not at all, until the heat is restored.

INTESTINAL DIGESTION.

Structure of the Intestines.— The *small intestine* is a tube, lying in a coil, through which the food passes after leaving the stomach. It is about one inch in diameter and twenty feet long. The *large intestine* is twice as large and five feet in length. This gives to the whole canal below the stomach a length of about twenty-five feet.

Like the stomach, the intestines have three coats. The *inner*, or *mucous*, *coat* sends out fluids called the *intestinal juices*. These mix with the chyme coming from the stomach, and convert into sugar a portion of the starch which has before escaped digestion.

The *middle coat* of the intestines consists mostly of rings of muscle, and is called the *muscular coat*. These rings, beginning with the one nearest the stomach, contract, one after the other, like those of the esophagus. This action forces the contents onward, and finally expels

the waste portion from the body. The *outer coat* is similar to the outer coat of the stomach.

The Pancreas.— Lying back of the stomach is an irregularly shaped organ, about six inches in length, called the *pancreas.** Its office is to secrete a fluid called the *pancreatic juice*, and send it out into the upper part of the small intestine,† to mix with the chyme as it passes through this place from the stomach.

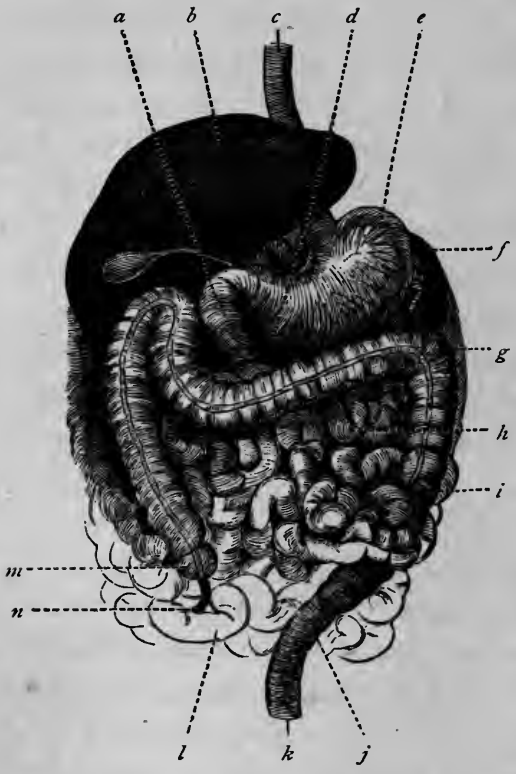

FIG. 10.— The organs of digestion: *a*, duodenum, leading out of the pylorus; *b*, liver; *c*, esophagus; *d*, pancreas; *e*, stomach; *f*, spleen; *g*, *i*, *j*, *k*, *m*, *n*, parts of large intestine; *h*, *l*, small intestine.

When the chyme leaves the stomach, the oily portion lies on the surface. The pancreatic juice then unites with it and divides it into minute particles and mixes it through the whole mass of chyme, as the oily particles of cream are divided and mixed in milk. A part of the oil is converted into a substance resembling soap.

The Liver.— The liver is a large organ lying on the

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* In animals whose flesh we eat, the pancreas is called the *sweetbread.*

† This part is called the *duodenum* because it is about twelve finger-breadths in length.

right side under the lower ribs. It is an important organ, having several kinds of work to do. One of these is to pour a fluid, called *bile*, upon the food passing through the upper part of the intestines.

That the bile contains waste matter which the blood must get rid of is shown by the fact that when it does not pass off as it ought to, the body becomes yellow, and the person is said to have *jaundice*. The bile assists the pancreatic juice in preparing the fats and other food substances in the chyme for entering the blood. It also excites the intestines, or *bowels*, to pour out a juice that renders easy the passage of waste matter through them.

By the action of the pancreatic juice and the bile in the upper part of the intestines, the chyme is converted into a milk-like substance, called *chyle*.

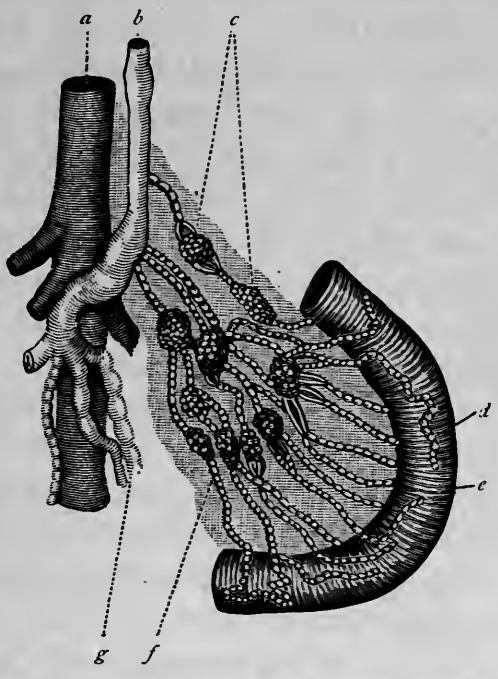

FIG. 11.—The lacteals and their connections: *a*, portal vein; *b*, *g*, thoracic duct; *c*, groups of lacteals; *d*, *e*, intestine; *f*, lacteals.

The Lacteals.—All along the intestines are little absorbing tubes known as *lacteals*.* These unite in little groups and form larger tubes. These at last all terminate in a single tube, about

* It is estimated that these lacteals number about seven thousand in each square inch of surface, and that in the entire length of the intestines they number from three to five millions.

the size of a goose quill, which lies in front of the spinal column, and is known as the *thoracic duct.*

Absorption.— As the chyme passes through the upper part of the intestines, the portions fit to make blood soak into little tubes that run through the inner lining of the intestines like fine network. These little absorbing tubes are of two classes, (1) the *lacteals* and (2) the *small blood vessels* like those in the inner lining of the stomach. The food that soaks into the lacteals consists chiefly of fats, and is carried by them to the thoracic duct. Ascending through that duct the fatty food is poured into a vein which lies under the left collar bone;* and finds its way to the heart through the large vein coming from the upper parts of the body.

The food that enters the small blood vessels of the intestines is carried by the blood in them to the portal vein, where it is joined with blood coming from the stomach and carrying the food matter taken up by the tiny absorbing tubes there. From the portal vein this blood, rich in new food material, is poured into the blood vessels of the liver. There it is still further changed and prepared for building up the body, as it flows with the blood to all the various parts. This process by which food is taken up by the lacteals and small blood vessels is called *absorption.*

Alcohol in the Stomach.— When a person drinks wine, beer, whisky, or any intoxicating liquor, the hot, biting alcohol it contains irritates the inner coat of the stomach. The glands of the stomach will then quickly pour out their watery fluids to soothe the irritated coat, just as the glands of the eye send out tears when anything hurts the eyeball. If the stomach is often irritated in this way

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* This vein is called the *subclavian.*

the glands are exhausted by being compelled to provide so much extra fluid. Then, when food enters the stomach, the glands of the inner coat do not pour out enough gastric juice to properly digest the food.

As alcohol has great power of absorbing water, it takes moisture out of the mucous coat of the stomach. In this way the stomach of the habitual drinker becomes hardened and unable to supply gastric juice enough for digestion. If the drinking is then kept up, more or less active *inflammation* always sets in, often causing long illness, or death.

Alcohol will also absorb the water from the food that it finds in the stomach, thus hardening it. In this way it is made more difficult for the digestive organs to dissolve the food of the drinker to a fluid that may enter the blood. This hardening effect may be seen by pouring a little alcohol upon the white of an egg. The egg is quickly hardened, as if it had been cooked. Instances are on record where alcoholic drinks, taken freely with food, have rendered the food so indigestible that it has remained for hours in the stomach undissolved, and has been ejected in much the same state in which it was swallowed.

Another Way in which Alcohol hinders Digestion.— The power of the gastric juice to dissolve certain kinds of food depends upon a substance contained in it which is called *pepsin*. If a small quantity of gastric juice is put into a bottle, and to it is added an alcoholic liquor, the pepsin may at once be seen, in the form of a fine white powder, settling to the bottom of the bottle. If an alcoholic liquor is taken into the stomach while food is being digested by the gastric juice, the pepsin in it is separated as in the bottle. The gastric juice will not then have the effect upon the food that it had before; and

fresh juice must be poured out by the glands until the alcohol is so weakened that it will no longer separate the pepsin.

Alcohol has another peculiar effect. Its action on the stomach often leaves a sickly, sinking sensation, which can be relieved by nothing but alcohol; and so drink induces drink, until the habit is formed from which no one can escape without great suffering.

In many instances an appetite for alcoholic drinks has been formed by people who have taken them under the false impression that they would assist digestion, but they hinder instead of helping it. Alcohol may cause ulcerous sores and other serious diseases of the stomach, while it creates the dreadful appetite that craves nothing so much as the liquor that caused the disease.

While the alcohol is working injury in the stomach, the little blood vessels are trying to get rid of it. They take it up unchanged, and pass it on into the larger ones. These carry it to other parts of the body, where it repeats the mischief it has begun in the stomach.

Tobacco and the Stomach.— Tobacco contains a dark, bitter, resinous substance that irritates the inner lining of the stomach in persons who chew or smoke it. It is this substance that produces the deathly sickness when tobacco is smoked or chewed for the first time. The stomach may be made, by continual use, to accustom itself to the presence of this irritating matter, and its effects may not for some time be apparent; but the tobacco diminishes the amount of gastric juice, hinders digestion, and often brings on dyspepsia.

A sharp, biting fluid often gathers in the stomach of the tobacco user after digestion is completed, causing him *heartburn* and *nausea*. Sometimes he has an unnatural

craving for vinegar or other acids to overcome the alkaline * effects of the tobacco.

Tobacco also weakens the muscles in the walls of the stomach that keep up the churning motion during digestion, and the muscles in the intestines that keep their contents in motion.

The tobacco user often loses his appetite for food while his craving for tobacco remains the same. He sometimes argues from this that the tobacco is serving him as food, and is therefore good for him. But instead of giving strength, as food would, tobacco reduces the strength, and makes the system more liable to disease and less able to resist unhealthful influences.

Dyspepsia is a disease of the stomach quite common to tobacco users. Dr. Taylor says: "A poisonous substance like tobacco, whether in powder or juice or vapor, can not be brought frequently into contact with an absorbing surface like the mucous membrane (the lining of the mouth and stomach) without in many cases producing disorder of the system which the consumer is probably quite ready to attribute to any other cause than that which would render it necessary for him to deprive himself of what he considers not merely a luxury, but an article necessary to his existence."

Alcohol and the Liver.— The liver is especially liable to injury from the use of alcohol, for the reason that whenever alcohol is taken into the stomach it is carried directly to the liver by the same veins that carry the food. The liver is so constructed that it will retain for some time,

* An *alkali* is the opposite of an acid, and when the two are united in the right proportions the one destroys the effects of the other. Ammonia is an alkali, and so is soda. Each of these may be neutralized by vinegar, lemon juice, or other acids.

in its fine mesh-like tissues, substances that are unfit to circulate in the blood.

Dr. B. W. Richardson says: "The liver of the confirmed user of alcohol is probably never free from the influence of the poison; it is too often saturated with it."

When two or three glasses of wine are drunk every day, the liver tissues may become irritated, inflamed, and after a time seriously diseased. When the liver becomes thus disordered from the irritating effects of alcohol, it can not do its work properly. The food matter, brought to it by the blood from the stomach and intestines, is not prepared as it should be to nourish various parts of the body. An overabundance of sugar may be produced, leading to a serious disease of the kidneys, or an overabundance of fat, resulting in the flabby muscles and bloated body of the beer drinker. When too much fat is produced the liver itself often becomes overloaded with it. Minute oily drops gather in between the little liver cells and crowd them, or the *liver tissue itself changes to fat*, which can by no means perform the work of the tissue it has displaced. Fatty livers can be produced in animals by feeding them with alcohol.

The continued irritation of the liver by small quantities of alcohol, as in the case of the wine, beer, or cider drinker, often leads to an incurable disease called "gin liver," or "hobnailed liver." The connective tissue of a liver often becoming inflamed contracts, causing the liver in some places to shrink, while in others it is expanded. In some cases of this kind, the liver after death has been found so hard that it could scarcely be cut with a knife.

OTHER NARCOTICS.

Opium is the dried juice of the seed pod of the poppy. It is a powerful narcotic that deadens the nerves, and is

capable of causing stupor that ends in death. It is sometimes given by physicians to deaden pain. Like alcohol, it has the power of creating an almost uncontrollable craving for itself. The habit of using it is easily formed and very hard to break. Its use causes disease of the digestive organs, waste of flesh, feebleness of blood circulation, but worst of all, great impairment of the brain. The mind becomes dulled and the will weak, while the craving for the drug grows stronger and stronger with every repetition of its use.

Morphine is extracted from opium, and affects the human system in much the same way as opium.

Chloral is a narcotic substance sometimes prescribed by the physician to produce sleep. Its effects upon the system are similar to those of other narcotics, and it should never be resorted to except under a physician's directions.

Opium, morphine, and chloral are usually taken at first to relieve pain or induce sleep. The use of repeated doses of either of these drugs is quickly followed by a craving desire for more, that is found very hard to resist. Such a craving, gratified, will destroy the health, the mind, and the character.

HYGIENE OF DIGESTION.

Like other parts of the body, the digestive organs need rest. If kept constantly in action, they become exhausted and unable to perform their proper work. From this fact, and from the lessons which have gone before, we derive the following hygienic laws:

I. Take food that can be digested.

II. The food should be so prepared as to digest most easily.

III. Enough food should be taken to nourish the body, and no more.*

IV. Food should be taken at regular times, with sufficient intervals to give the digestive organs a chance to rest.†

V. At mealtimes, and until digestion in the stomach is nearly finished, water and other liquids should be taken sparingly.

VI. Avoid all substances, like unripe fruits, that have a tendency to create disturbance in the intestines.

VII. Avoid the use of tobacco, as it prevents the changes which should be made by the saliva, and does other damage.

VIII. Avoid the use of alcoholic drinks, because they prevent the changes which should be made by the gastric juice and by the liver.

IX. Alcohol irritates the coats of the stomach, injures its gastric juice, and hardens the food that should be dissolved in the stomach. It is injurious to digestion. We should not drink wine or any liquor that contains alcohol.

X. Opium, morphine, and chloral are dangerous nar-

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* The best guide to the proper kind and amount of food is a healthful appetite. As there is a pleasure in eating, however, there is danger of eating too much, especially if the food is taken rapidly. The appetite, too, may be spoiled by various indulgences, and then it ceases to be a guide. In such cases, the only way we can determine what is best for us is by the study of the nature of foods, and by experience as to what seems to suit our own conditions best.

† If children must eat candy and sweetmeats, the best time for them is directly after a meal, as the habit of eating between meals is very injurious. After a long process of digestion, the digestive organs become tired, and it is wrong to overtax them. We ourselves need a rest after a hard task, and are discouraged, if, when our work seems to be done, more is given us to do. So it is with the digestive organs. It is not fair to keep them constantly at work.

cotics. Frequent doses will create a craving for more. Avoid the use of either of these poisons.

SOMETHING TO FIND OUT.

1. What is the work of the outer coat of the stomach? What does the muscular coat do?

2. What good results from the arrangement of the muscular coat in layers acting in different directions?

3. What effect has the gastric juice upon starch?

4. When the mouth is full of food, should we take drink to "wash it down"?

5. Why is it better to take drink toward the end of a meal than at the beginning?

6. What is the effect of taking ice cream after a meal?

7. How do vinegar and sour fruit sometimes improve digestion?

8. Why are biscuits containing a large quantity of soda hurtful?

9. Under what circumstances may it be proper to take a little soda into the stomach?

10. Should we take food "between meals"? Why?

11. Should we eat just before going to bed? Why?

12. What is the harm of eating when we are tired?

13. Should we engage in violent exercise just after a meal?

14. What is the best condition to be in for the half hour before and after meals?

15. What are the best foods for invalids and persons with weak stomachs?

16. What is the general difference between a diet proper for summer and one proper for winter?

17. How can we avoid the evil effects which tobacco causes in the stomach?

18. In what way is the habit of taking alcoholic drinks formed?

19. How can we avoid the suffering caused by breaking off such a habit?

20. Why do people begin the use of strong drink?

21. What is the effect of eating so much at a meal as to overload the stomach?

22. Mention some remedy for the evil of overeating.

23. What is better than medicine to preserve a healthy digestion?

24. What effect do liquors containing alcohol have upon the lining of the stomach?

25. How does irritation affect the glands of the stomach?

26. What is the effect of repeatedly irritating the stomach in this way?

27. How does alcohol affect the moisture of the inner coat of the stomach?

28. What does it produce in the case of the habitual drinker?

29. How does it affect the gastric juice?

30. How does alcohol make the food in the stomach less fit for digestion?

31. By what simple experiment may this be illustrated?

32. What is pepsin, and what does it do?

33. What does alcohol do to the pepsin in the gastric juice?

34. What experiment shows this?

35. When alcohol disturbs the relation of the pepsin to the gastric juice, what follows?

36. What sensation is created in the stomach by the use of alcoholic drinks?

37. What is the result of taking more alcohol to relieve this sensation?

38. What serious diseases sometimes result from the same cause?

39. How is alcohol carried from the stomach to other parts of the body?

40. What substance is found in tobacco?

41. How does it affect the gastric juice? Digestion?

42. To what disease does it give rise?

43. What effect does tobacco have upon the muscles in the walls of the stomach? What effect upon the appetite?

44. Does tobacco give strength?

45. To what does it make the system more liable?

46. What disease is quite common among tobacco users?

47. What does Dr. Taylor say about tobacco?

48. What organ of the body is especially liable to injury from the use of alcohol?

49. What does Dr. Richardson say concerning the confirmed alcohol user?

50. How is the liver affected when two or three glasses of wine are drunk every day?

51. How does this affect its work?

52. To what disease of the liver does the continued use of small quantities of alcohol often lead?

53. What is opium, and what is its character?

54. Why is its use dangerous?

55. What is the effect of its use upon the digestion?

56. What will it do to the mind?

57. What is morphine?

58. What is chloral?

59. Why should we not use opium, morphine, or chloral?

TOPICAL ANALYSIS OF CHAPTER V.

How Digestion goes on.

Stomach Digestion.

1. Structure of the stomach.
2. Muscular action.
3. The gastric juice.
4. Starchy foods changed to sugar by action of saliva.
5. Albuminoid foods dissolved by gastric juice.
6. Absorbing blood vessels.
7. Chyme.
8. Character and amount of drink.

Intestinal Digestion.

1. The intestines: small — large — structure — juices — action.
2. The pancreas: pancreatic juice — uses.
3. The duodenum.
4. The liver: bile — nature — uses.
5. Chyle.
6. The lacteals: thoracic duct.
7. Absorption: lacteals — blood vessels — portal vein.

Digestion affected by Alcohol and Tobacco.

1. Alcohol in the stomach.
    1. Irritates and excites.
    2. Exhausts the glands.
    3. Hardens the stomach and the food.
    4. Continuous use inflames.
    5. Separates the pepsin.
    6. Produces peculiar cravings.
2. Tobacco in the stomach.
    1. Irritates.
    2. Hinders digestion.
    3. Causes dyspepsia and heartburn.
    4. Weakens the muscles.
3. Alcohol in the liver.
    1. Irritates and inflames.
    2. Changes tissue to fat.
    3. Hardens and causes "gin liver."
    4. Produces disease of the kidneys.

Other Narcotics.

1. Opium: juice of poppy — creates unnatural craving — weakens the body — injures the mind.
2. Morphine extracted from opium.
3. Chloral — effects like other narcotics.

Hygiene of Digestion.

Something to find out.

CHAPTER VI.

How the Blood is purified.

THE new blood made from the dissolved food brought by the lacteals and small blood vessels is poured into veins, where it mingles with the other blood in the body. This blood is laden with worn-out materials which the body has used, and before it can go to build up the body it must be purified. For this purpose, it must come in contact with air.

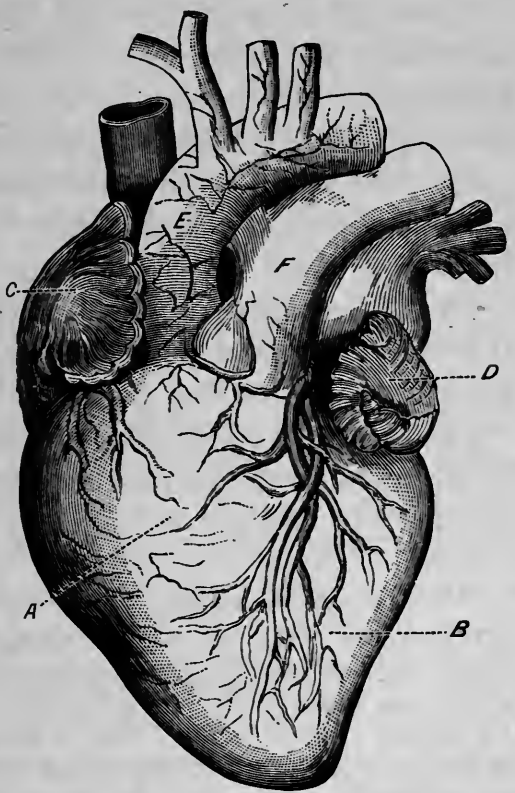

FIG. 12. — The heart and large blood vessels: *A*, right ventricle; *B*, left ventricle; *C*, right auricle; *D*, left auricle; *E*, aorta; *F*, pulmonary artery

THE HEART.

On its way to the lungs, the blood carried by the veins first enters the heart. This organ is placed in the chest between and partly behind the two lungs, and

slightly on the left side. It is about as large as the fist, and is shaped somewhat like a pear. It points downward toward the front. It is made up chiefly of strong muscular fiber, so that it can contract with very great force.*

The Plan of the Heart. — The right and left sides of the heart are entirely separated by an unbroken wall of muscle. In structure, the two sides are nearly alike, but each has its own separate work to do. The right side receives the blood from the veins and sends it to the lungs to be purified. The left side receives the blood from the lungs and sends it out to build up the system.

Each side of the heart has two cavities, the smaller one being above, and the larger below. The upper cavities are called *auricles*, and the lower ones *ventricles*. As the blood flows from the veins into the auricles gently, the walls of the upper part of the heart are not so thick and strong as if they were intended to sustain a heavy strain.

By the ventricles the blood must be forced, or driven, through the blood vessels, and, in consequence, the muscular walls of the ventricles are thick and strong.

Between the auricles and ventricles are *valves* opening downward, which admit blood freely from above, but which close and prevent its return. The blood vessel

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* It has been found that, during twenty-four hours, the average healthy human heart does an amount of work equivalent to raising 92.425 tons one foot high, or of raising one ton over 92 feet. A good climber can only raise his own weight 9000 feet in nine hours, or 1000 feet an hour; while the work done by the heart is equivalent to raising its own weight (ten ounces) 13,860 feet an hour. The most powerful engine ever made by man, the "Bavaria" locomotive of the Vienna and Trieste Railway, can only raise itself through 2700 feet in an hour; that is, its energy is less than one fifth of that of the human heart. ("The Heart and its Function.")

leading from the right ventricle to the lungs is called the *pulmonary artery*.

The Blood on its Way to the Lungs. — 1. The currents of blood from the veins, one from the upper extremities of the body and one from the lower,* unite and empty into the right auricle of the heart. 2. The walls of the right auricle force the blood through the valve into the right ventricle. 3. The powerful muscular walls of the ventricle then contract, the valve shuts, and the blood is driven through the large artery to the lungs, where it comes in contact with the air to be purified.

Nerves of the Heart. — Besides the nerves in the muscular walls of the heart which cause it to contract and force out the blood, there are two sets of nerves that act as regulators of the heart's action. Those belonging to one set † have an *exciting* influence, causing the heart to beat faster. Those belonging to the other set ‡ act as a *check* or restraint, and keep the heart from going too fast, somewhat as a brake that is put upon the wheels of a wagon keeps it from going too fast down a steep hill. If the brake is taken off, the wagon is in danger of running upon the horses.

Action of Alcohol upon the Heart. — We have learned that alcohol is a narcotic, or deadener of the nerves. When from the stomach it passes into the blood, it very soon comes into contact with the many nerves of the body. The restraining nerve of the heart is one of the first to be affected by it. Very quickly this nerve becomes so deadened or paralyzed by the alcohol that its power of holding the heart in check is greatly reduced. Just as the wagon wheels begin to fly around faster when the brake is taken

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* The large vein from above is called the *superior vena cava;* and that from below, the *inferior vena cava.*

† *Accelerator nerves.* ‡ *Inhibitory nerves.*

off, so the heart begins to beat faster when its brake, the restraining or inhibitory nerve, is deadened or partially paralyzed by alcohol.

The heart of a man in good health beats about seventy-three times in a minute. At each beat it lifts about six ounces of blood, which in an hour amounts to 26,280 ounces, or 1642 pounds. A small quantity of alcohol, as for instance that contained in three glasses of beer drunk in the course of a day, or a couple of wine-glassfuls of wine at each meal, will by paralyzing the inhibitory nerves of the heart cause it to beat *two hundred and fifty extra strokes every hour.* This would mean lifting ninety-three and three quarter more pounds of blood every hour than it ought. No wonder such a drinker feels tired after his heart has been thus overworked! This increase of work is thrown upon the heart without increase of nourishment, for there is no nourishment in alcohol, and with a shortening of the usual time for rest between the heart's beats. The heart in a healthy condition rests for a brief instant between its beats.

Thus we see that the frequent use of alcohol, though in small quantities at a time, puts extra work upon the heart and renders it liable to disease. Sometimes the muscles enlarge and partially fill up the cavities which the blood should occupy. Sometimes the cavities enlarge and the muscular walls grow thin. Sometimes the substance of the muscles gradually changes to a fatty substance which has no power to contract forcibly upon the blood, or to bear the strain put upon it by the pressure of the swift-flowing blood current. Each of these diseases of the heart is exceedingly dangerous, and *liable at any time to cause sudden death.* We are assured by the testimony of able physicians who have investigated the matter that alcohol is a frequent cause of these and other

diseases of the heart. We have also evidence furnished by carefully prepared tables, which shows that those who frequently take alcohol even in small quantities are more liable to heart diseases than those who do not.*

THE LUNGS.

The *lungs* are in two divisions, occupying the right and left sides of the upper part of the chest. The

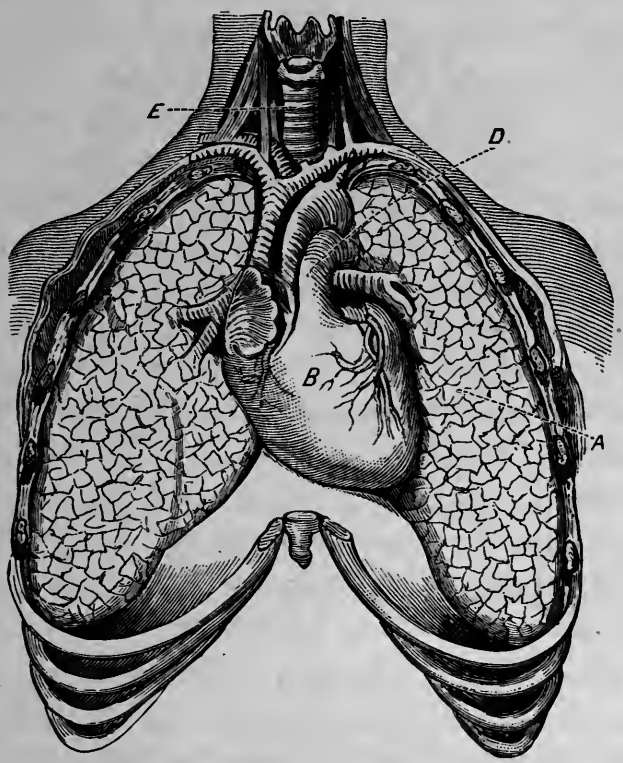

FIG. 13. — The cavity of the chest, showing the positions of the heart and the lungs: *A*, left lung; *B*, heart; *D*, pulmonary artery; *E*, trachea, or windpipe.

right side has three distinct parts called *lobes*, the left two.

Structure of the Lungs. — The lungs are made up of

* Dr. George Harley, "London Lancet," March 10, 1888.

soft, elastic tissue arranged in the form of minute cells. These cells are connected with small passages, which open into larger ones, uniting in a single pipe — the small passages are the *bronchial tubes;* the two larger ones are the *bronchi;* and the pipe into which these

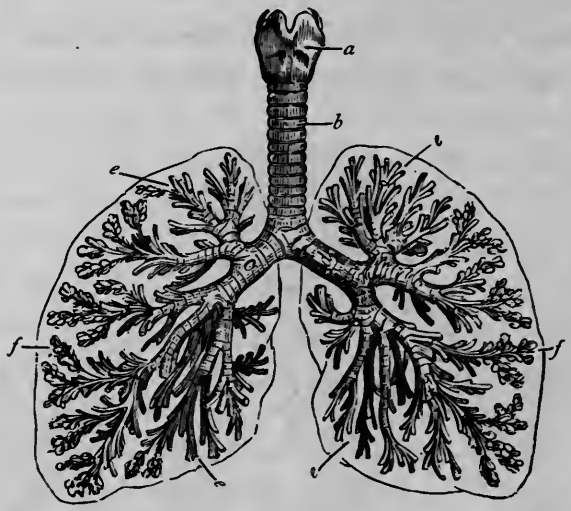

FIG. 14. — Air passages in the human lungs: *a*, larynx; *b*, trachea; *c*, *d*, bronchi; *e*, bronchial tubes; *f*, clusters of air cells.

open is the windpipe, or *trachea.* Lying next above the trachea is the *larynx,** which opens directly into the throat, and through the nasal passages and the mouth into the air.

The artery which brings the blood to the lungs from the right ventricle of the heart is a single tube; but it finally divides into five branches, one extending to each of the five lobes of the lungs.

Entering the lungs, these blood vessels divide into minute passages, which extend to every part of the lungs and surround every air cell. Indeed, the lungs may be

* The larynx makes a lump in the neck which we can feel, and which is called "Adam's apple."

considered as made up of air passages and blood vessels, with just enough tissue to form the necessary cells and tubes.* The lungs are surrounded by a smooth membrane.

Breathing. — When we breathe certain muscles attached to the ribs contract, and move the ribs outward and upward. At the same time other muscles attached to the diaphragm contract, and draw this partition down, making the cavity of the chest broader and deeper. When these muscles relax, the ribs droop downward, the diaphragm returns to its arched position, and the chest is narrowed and shortened.

When the ribs are elevated and the diaphragm is depressed, the air forces its way into the air passages of the lungs, and expands the lung tissue so that it fills the enlarged space within the chest. When the ribs and the diaphragm return to their passive condition the elastic tissue contracts, forcing the air out.

Action in the Lungs. — The air, when it is breathed in, enters through the nose † or the mouth into the bronchials, and finds its way into every little air cell. The walls of these cells, separating them from the blood vessels, are so thin that air and gas readily pass through. In this way the impure matter in the blood finds its way

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* If two small trees with bushy tops were placed together in such a way that the branches and twigs of one were closely interlaced with the branches and twigs of the other, they would show how the divisions of the pulmonary artery and those of the air passages are brought together in the lungs.

† The outer nasal passages are supplied with fine hairs, so that the air on its way to the lungs is filtered, and no dust is allowed to pass. The nose has also the sense of smell, and whenever it detects foul odors the air is unfit to breathe. The nose thus becomes a sentinel at the gate of the lungs. For these reasons we should *always breathe through the nose instead of through the mouth.*

into the air cells, and the *oxygen* * of the air enters the blood vessels.

Results of Breathing. — The air, which comes into the lungs pure, goes out laden with carbonic-acid gas † and other impurities. It is so foul that it is unfit to be breathed again.

The blood, which comes into the lungs laden with impurities, gives off waste matter, and receives life-giving oxygen. Its color is changed from a dark, dull red to a bright scarlet, and it is filled with the strength and health necessary to nurture the body.

Return of the Blood. — The blood, thus purified and strengthened, flows from the small blood vessels in the air cells into larger ones that carry it back to the heart, where they pour it into the left auricle. The blood is now purified and ready to be sent out to nourish all the parts of the body.

Alcohol in the Lungs. — The alcohol which entered the blood vessels from the liver is soon carried to the lungs. As it does not become a part of the blood, or furnish it with any needed element, an effort is here made to get rid of it, and the effect is shown in the peculiar and disagreeable odor of the breath of habitual drinkers.

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* Oxygen is a gas which makes up a little more than one fifth of the weight of ordinary air, and about eight ninths of the weight of water. It is the action of oxygen that makes our fires burn and our lamps give light. It is by a similar action of oxygen upon the tissues of their bodies that all animals are kept alive. Fishes get oxygen from the water by means of their gills.

† Carbonic-acid gas is one of the products of worn-out animal tissue. It is also produced by burning wood and coal, and in other ways. Air that contains much of it is unfit to breathe. It is, however, one of the principal supporters of vegetable life. Vegetation takes up carbonic acid and pours out the oxygen necessary to animals. The two great divisions of living things thus continually work for one another.

But the lungs have enough to do to relieve the blood of its waste matter. If the amount of alcohol is large, the lungs can not get rid of the whole of it, and a portion is carried back from the lungs to the heart, and thus mingles again with the currents that circulate through the body. Here, as before, the alcohol is in the blood, but not a part of it, and efforts are made to expel it wherever it appears.

We have seen that the lungs are composed of very delicate tissues. Alcohol has a *hardening and injurious effect upon the tissues* of the body, especially upon those of the lungs. For a time after an alcoholic drink has been taken, the blood vessels of the lungs, as well as those of other parts of the body, are overcharged with blood, increasing the liability to inflammation of the lung substance. The continuation of the practice of drinking leads often to serious changes in the tissues of the lungs, rendering them liable to *hemorrhage*, or bleeding. A noted English physician,* who has made a study of chest and lung diseases, says that this condition of the lungs is common among free beer drinkers, and that after death traces of such hemorrhages may be found in the lungs together with a thickened condition of lung tissue. When lungs in this condition break down, he says their destruction is likely to be very rapid.†

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* Dr. R. E. Thompson, of Brompton Hospital for Consumptives.

† In California, where wine drinking is commonly practiced, a form of consumption resembling that of beer drinkers is common. These facts go to show that alcohol is not, as some have supposed, a preventive of consumption, but rather a cause. Still further evidence is the fact that among British soldiers stationed at home — where intemperance is a prevailing vice — the two most frequent serious diseases are *delirium tremens* and *consumption*. It is also found that among the diseases which the children of intemperate parents are likely to inherit consumption has a prominent place. (Palmer's "Science and Practice of Medicine," vol. ii, p. 294.)

Tobacco in the Lungs. — In smoking, the fumes of tobacco are frequently drawn into the lungs. This is especially the case in smoking cigarettes. The effect of the tobacco upon the lung tissue is to make it unfit to do its work, so that all the changes effected by breathing are more slowly performed. In this way the blood goes on in its course without being sufficiently purified, and is therefore less able to properly nourish the body. The first result of this is a feeling of *languor*, and this, if frequently repeated, often becomes *torpor* and *stupidity*.

Tobacco affects children most unfavorably before they have attained their full growth. The action of the organs necessary for growth and bodily and mental activity is retarded; the body becomes feeble, and is often stunted. The mind is rendered as weak as the body, and many times it loses all power of effective study.

The Need of Pure Air. — We have already seen that the air once breathed is no longer pure. It is just as unfit for breathing again as muddy water is for drinking or decayed food for eating. But air is rendered impure in many other ways. From stagnant water and from decaying animal and vegetable substances gases arise which make the air unfit for breathing. Whenever foul air is breathed, the blood is not fully purified, and the body is not properly nourished. Some of the most fatal diseases result from breathing air laden with foulness.

Ventilation. — Enough poisonous and waste matter to spoil half a barrel of air is thrown out by the lungs at every breath. Thus in a short time the air of a small sleeping room is made impure, even if only one person is breathing it. In this way the air of a close schoolroom filled with pupils, or that of an unventilated church, hall, or parlor crowded with people, soon becomes wholly unfit to breathe. Each pupil or person in such a room is making

the air more poisonous for himself and others with every breath. Fresh air should be let in and bad air let out.

Unless a room is very large, no one should remain long in it with the doors and windows closed. Every inhabited room should have some good means of *ventilation.*

As no one should stay long in a room without some kind of ventilation, if nothing better can be done the doors and windows on opposite sides of the room should be opened for a short time every hour, allowing the bad air to escape and fresh air to enter. If this is done in a schoolroom, the pupils should meanwhile march or go through some form of gymnastic exercise to prevent their taking cold. In very cold weather the drafts of stoves or furnaces should be turned on when the windows are first opened, so that the cold air thus admitted may be warmed as quickly as possible.*

If cold air from an open window in the sleeping room can not be borne, a door in the warm room occupied may be left open into one adjoining where there is an open window. The chill of the pure air will thus be taken off by the warmth of the stove or furnace heat in the occupied room before it comes to the lungs of the sleeper.

Sleeping rooms that have been used the night before, with their beds and bedding, as well as other rooms of the house, should be *thoroughly aired every morning.* Doors and windows should be opened until all the foul air is driven out, and fresh, pure air has taken its place.

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* A simple way of ventilating a room in cold weather is to raise the lower sash and fit a board underneath it, to keep the air from pouring in and causing a *draft.* A supply of fresh air will enter through the opening between the two sashes in the middle of the window, and coming in with an upward motion will become warm before falling down upon the heads of those sitting near the window.

Fresh air should be let into *schoolrooms*, *churches*, and *public halls* for the people to breathe while they are there. After the school or audience has left, these rooms, before being closed, should be thoroughly aired by opening windows that are opposite each other. To heat these rooms for use the next day without thus changing the air within their walls is to give their occupants warmed-over impurities to breathe.

HYGIENE OF RESPIRATION.

As air is a necessity of life, some of the rules that should guide us in regard to air become obvious:

I. When the nose detects an unpleasant odor, the air is foul, and we should avoid breathing it, if possible.

II. We should not breathe air that is made foul by our own breath, or by that of other persons.

III. We should not stay long in a crowded room, unless it is well ventilated.

IV. We ought not to sleep in small, ill-ventilated bedrooms.

V. Impurity of air in a room may not be detected except when coming in from fresh air; hence extra care should be taken to thoroughly ventilate all occupied rooms every day.

VI. We ought to keep away from the vicinity of stagnant water.

VII. We should never permit decaying animal or vegetable matter to remain near our houses.

VIII. We should carefully avoid breathing the gas from sewers, sinks, and cesspools.

IX. We should avoid alcohol, tobacco, and other articles that give extra foulness to the breath.

X. No article of dress should be worn so tight as to prevent the expansion of the chest in respiration.

XI. The weight of the clothes should hang from the shoulders, and not be supported by bands about the waist.

XII. We should never sit or stand in such a way as to cramp the chest and prevent full and free respiration.

SOMETHING TO FIND OUT.

1. What parts of the body lie next to the heart?
2. With what nerves is the heart supplied?
3. What effect does alcohol have upon the nerves?
4. How does it affect the restraining nerve of the heart?
5. What effect does this have upon the heart's action?
6. How often should the heart of a healthy man beat in a minute?
7. What effect will three glasses of beer per day have on the beating of the heart?
8. How many extra pounds of blood will this oblige the heart to lift every hour?
9. Does alcohol furnish any nourishment to sustain the heart in its extra work?
10. How does alcohol affect the time for rest between the heart's beats during this extra exertion?
11. In what does this extra work often result?
12. What evidence shows that the use of alcoholic drinks gives rise to heart disease?
13. How may the lungs of a sheep or a calf, which we get from a butcher, be filled with air?
14. When these lungs are full, how is the air driven out?
15. About how much force is required to inflate our lungs?
16. Why is it more difficult to breathe on the top of a high mountain than at the bottom?

17. Why is it more healthful to travel after a rain than before?

18. What organ serves the lungs by giving warning of the presence of foul substances?

19. What should we do when we get a strong smell of carrion?

20. Why should we not take a pan of live coals into the bedroom which we occupy?

21. What shall we do when we detect the presence of carbonic-acid gas in our rooms?

22. In what way does foul air affect the pupils of a school?

23. How should the cellar of a house be kept?

24. What kind of sink in a kitchen is harmful?

25. Why would it be well to burn in the kitchen stove or range all potato parings, the waste part of vegetables, and any pieces of tainted meat?

26. Why should we particularly avoid taking the breath of persons who are ill?

27. When resting after violent exercise, what precaution should we take?

28. Why does tobacco affect children worse than it does grown people?

29. How do we know that the lungs remove alcohol from the blood?

30. Why should not this work be put upon the lungs?

31. What is the condition of the blood vessels of the lungs after an alcoholic drink is taken?

32. How may the tissues of the lungs suffer?

33. What lung diseases are often the result of the use of alcohol?

34. What does an English physician say concerning the lungs of severe beer drinkers after death?

35. What effect has tobacco smoke upon the tissues of the lungs?

36. What is the condition of the blood when the lungs are made unable to do their work?

37. At what time of life does tobacco work the greatest injury to those who use it?

38. How does it affect the whole body?

39. What does it do to the mind?

40. What can be done when no better means of ventilation has been provided?

41. How may the air of a sleeping room be kept pure and not too cold in severe weather?

42. What should we be careful to do to our sleeping rooms, beds, and bedding every morning?

43. Why should not schoolrooms, halls, churches, and parlors be immediately closed after the pupils or other occupants have left?

44. What is the best way to avoid the stupefying effect of tobacco in the lungs?

45. How much air does a person spoil at every breath?

46. Why should no one sleep in a room with all the windows and doors closed?

47. In building a schoolhouse or a dwelling house, why should we place it at a distance from a swamp?

48. Why will a person coming into a room from the outdoor air detect impure air in a room, while the inmates are unconscious of the impurity?

49. In building halls, churches, and places of public resort, what matter needs special attention?

50. When the people at church or while attending a lecture become sleepy, what is probably the matter?

51. As the cost of ventilating a single schoolroom does not exceed twenty dollars, what excuse has the district for not providing means of ventilation?

TOPICAL ANALYSIS OF CHAPTER VI.

How the Blood is purified.

Movement of the Blood.

1. The heart: shape — position.
2. The plan of the heart:
   1. The right side.
   2. The left side.
   3. The auricles, ventricles, and valves.
3. The blood on its way to the lungs.
   1. From vein to right auricle.
   2. From auricle to right ventricle.
   3. From ventricle to the lungs.
4. Nerves: exciting — restraining.
5. Effects of alcohol upon the heart.
   1. Makes it beat too fast.
   2. Enlarges its cavities.
   3. Changes its muscles to fat.

Breathing.

1. The lungs: the lobes — elastic tissue.
   1. Air spaces: air cells — bronchial tubes — trachea — larynx.
   2. Blood flow around air cells.
2. The chest varies in capacity:
   1. By action of muscles attached to ribs and diaphragm.
   2. Movement of ribs and diaphragm.
3. Forces in breathing.
   1. The pressure of the air.
   2. The elastic force of the lungs.
4. Action in the lungs:
   1. Oxygen passes from air cells into the blood.
   2. Impure matter from blood passes into the air cells.
5. Blood returns to left auricle of the heart.

Alcohol in the Lungs.

1. Effort to expel alcohol with the breath.
2. Enfeebles the lungs.
3. Induces disease.
4. The blood imperfectly purified.

Tobacco in the Lungs.

1. Tobacco fumes drawn into the lungs.
2. Retards lung action.
3. Produces languor and stupidity.
4. Retards bodily growth.
5. Enfeebles the mind.

The Need of Pure Air. Ventilation.

Hygiene of Respiration.

Something to find out.

CHAPTER VII.

How the Blood nurtures the Body.

Waste and Repair. — Every time we take a step or raise an arm, portions of the muscles that move are used up. By every motion some part of the body is destroyed. Each action of the stomach, each breath, each beat of the heart, consumes tissue; and, indeed, it may be said that every part of the body is all the time wearing out.

But, during life, the nourishment of the body is also always going on. No sooner is one worn-out particle removed than another takes its place. On one side of each tiny cell the invisible sexton is hurrying away matter which is dead; on the other, the unseen builder is filling the vacant space with matter which is living. From birth to death these changes are going on. The agent that brings them about is the blood.

Blood Corpuscles. — In order that action and repair may go on, every part of the body must have not only food but oxygen, which is a part of the air we breathe. Oxygen is absorbed from the air in the lungs by minute

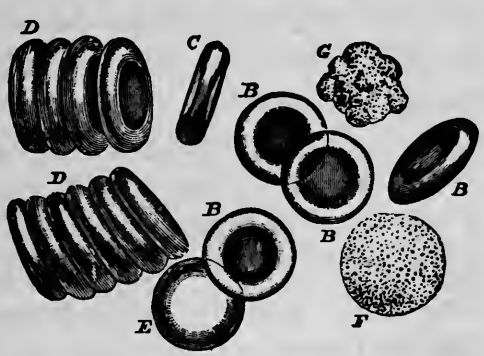

FIG. 15. — Blood corpuscles as they appear under the microscope: *B*, *C*, *D*, *E*, red corpuscles seen in different positions; *F*, *G*, white corpuscles.

little bodies that float in the watery part of the blood. These little solid bodies are called *blood corpuscles.* They are of two kinds, red and white. The *red corpuscles* are hollowed a little on each side and shaped somewhat like small flat shirt buttons, and are so small that three thousand five hundred of them could be placed side by side on a line an inch long. The *white corpuscles* are a little larger, and globe shaped. There is one white one to about three hundred red ones.

The Arteries. — The channels leading out from the heart are called *arteries.* They are made of a tough, elastic material, so that they retain their shape when pressed upon, and regain it when stretched or bent. Like the stomach, they have three coats.

The great artery leading out of the left ventricle of the heart is the *aorta;* it divides into large branches, which are sent upward to the head and upper extremities, and downward to the lower extremities. These branches divide again and again, until they terminate in minute tubes distributed to every part of the body.

The Capillaries. — From the extremities of the small arteries a network of fine, hair-like tubes, called *capillaries,* extends through nearly all the tissues of the body. These tubes lie so close together, that we can scarcely thrust the point of a fine needle into any part of the body without piercing some of them.

The Veins. — The capillaries open into minute *veins,* which join together and form larger ones, until they all unite in the two large veins, one from the upper extremities and the other from the lower. These two receive the blood and pour it into the right auricle of the heart. The walls of the veins yield more readily to pressure than those of the arteries.

Action in the Heart. — 1. As we have already seen,

the purified blood from the lungs pours itself into the left auricle of the heart. 2. The muscular walls of the auricle contract, and force the blood into the left ventricle. 3. Then the walls of the ventricle contract, the valve opening from the auricle shuts, and the blood is driven through the arteries into every part of the body.* To drive the blood so far and so rapidly requires a great amount of force, and therefore the walls of the left ventricle of the heart are very thick and strong.

Action in the Arteries. — The arteries are usually placed deep in the flesh, to be out of the way of harm. The blood is forced into them by *jets* at each heart beat. Their elastic walls yield to the rush, but contract again, helping the blood along its course.† In this way the minute vessels are filled, and the beating, or pulsation, which began at the heart is carried on to the extremities, so that every part of the body is quivering with motion and life.

Action in the Capillaries. — From the extremities of the small arteries the blood enters the capillaries. In each the stream is very minute and flows at an even rate. Here nutrition takes place. Oxygen from the blood unites with particles of tissue, causing both the *heat* and the *motion* of the body. The particles thus destroyed by

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* The average number of heart beats in a minute is greater in children than in adults, and greater in women than in men. With the body in a standing position, the heart has not only to force the blood to all parts of the body, but has to lift it from the chest to the head, and from the feet to the chest. When we lie down, the heart is relieved from this necessity of lifting, and its action is diminished.

† At the wrist, and at some other parts of the body where the arteries come near the surface, we can feel the *pulse*. Each beat of the pulse is the yielding of the artery to a beat of the heart. One of the surest means by which the physician finds out the condition of the body is the beating of the pulse.

use are taken up and carried away, and new particles full of life and strength are deposited in their place. In this way tissue is repaired, vigor is restored, health is kept up, and life is continued.

Action in the Veins. — The blood as it enters the veins from the capillaries is changed. The limpid current has become thick and turbid; the bright scarlet has deepened to a dark, dull red.* The jets have ceased, and the current flows on smoothly and evenly. All along the courses of the veins, *valves* open toward the heart, so as to allow the blood to freely flow in that direction; but they shut, so as to prevent its return. In action, the muscles press upon the veins and hasten the flow; so that work, play, and exercise of every kind, help the blood along its course.† From the veins the blood flows, as we have seen, into the right auricle of the heart.

Alcohol in the Blood. — The alcohol which the lungs can not expel returns to the heart and enters the general circulation. Although never becoming a part of the blood, its power for mischief continues. It causes blood corpuscles to shrink, probably by absorbing moisture from them. As these corpuscles are *oxygen carriers*, when they are injured they can not absorb and carry from

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* The rule that the *arteries carry scarlet blood*, and that the *veins carry dark blood*, has two exceptions. The artery leading from the heart to the lungs carries dark blood, and the veins leading from the lungs back to the heart carry scarlet blood.

† Persons who are obliged to stand much of the time are often troubled with what are called *varicose* veins. The forces that cause circulation are not sufficient to raise the blood from the feet to the heart through so many hours without rest; and in consequence the blood presses back on the veins until they yield to the pressure and gradually enlarge. The valves soon become useless, increasing the pressure and the enlargement. The only remedy is a change to some employment that will require less standing.

the lungs the oxygen which the body needs. Then the blood is not properly purified; dead matter enters the arteries, vitiating the blood; and the repair of waste is interrupted or imperfectly performed.

The arteries of the habitual drinker are likewise injured by alcohol. The walls of all these blood tubes are elastic. They may be expanded so as to hold more than their due amount of blood. The degree of expansion at which even the smallest blood tubes are kept, is regulated by nerves in their walls. When these nerves are weakened or relaxed, the pressure of the blood current causes the tubes to unduly expand and hold more than their usual supply of blood.

Alcohol has the same effect on these nerves in the walls of the blood vessels that it has on the inhibitory nerve of the heart. They become deadened or paralyzed, and that allows the blood vessels to expand, so that the blood flows too freely and to wrong places. Evidence of this paralysis is shown in the red face, red nose, and red eyes of the drinker. From these nerves being often paralyzed the walls of the blood vessels lose their power to contract, and thus become permanently stretched. They then contain all the time more blood than they should. Blood vessels in this condition are also liable to grow thin and to burst.

Alcohol and Cold. — After alcohol is drunk, the blood begins to flow to the surface of the body in larger quantities than it ought to, and a feeling of warmth is experienced. This has led to the belief that a little alcohol is good to warm the body, and the man who has to work out in the cold, thus misled, takes a drink to "warm himself up." The warmth which he feels lasts only a few minutes after the drink, and then he grows colder.

Alcohol paralyzes the nerves in the walls of the little

blood vessels that are in or near the skin; these vessels then expand and let too much blood come to the surface. There this excess of blood is much more quickly cooled than if it had remained, as it ought to, in the blood vessels that are farther from the surface, and the whole body is thereby made colder for the alcohol, and less able to bear exposure to severe cold.

Tests with the thermometer prove this, as well as numerous instances on record in which men have been exposed to intense cold. These instances show that great cold can be better endured without a drop of alcohol than with it.*

HYGIENE OF THE CIRCULATION.

I. We should breathe pure air, and frequently take long, deep breaths, so that the blood may be properly purified.

II. We should avoid the use of anything that disturbs the regular action of the heart and prevents the full nutrition of the body.

III. We should relieve the heart of much hard labor by taking regular and sufficient exercise.

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* A party of men crossing a Western plain were once obliged to spend a very cold night in the snow on the open prairie with no shelter but their wagons. They were advised by their leader not to use alcoholic drinks to help them in keeping warm, but only a few heeded this counsel. In the morning three men who drank themselves drunk during the night were dead. Four others who became only partially intoxicated were so badly frozen that they died from the effects within a few weeks. Six others who drank a little less than these, never recovered entirely from the effects. Seven others who drank still less had their toes and fingers frozen. Three who drank only a very little suffered intensely from the cold, but were not frozen. While the leader and two others who did not touch a drop of liquor, not only escaped being frost-bitten, but suffered less with the cold during the night than those who drank.

IV. Should the heart show signs of weakness, we may favor its recovery by taking a reclining position.

V. We may also greatly assist circulation, and so relieve the heart, by daily rubbing the skin briskly with a brush or coarse towel.

VI. We should avoid the use of all alcoholic liquors; for they paralyze the nerves that control the circulation of the blood, causing too much blood to flow to some places, and, if long continued, permanent enlargement of the blood vessels.

VII. The danger of taking cold or of freezing, arising from exposure to severe cold, is increased by alcoholic liquors. Such liquors are bad for the mind and body in all climates and should never be used.

SOMETHING TO FIND OUT.

1. When, and by whom, was the circulation of the blood first discovered?

2. If the heart beats seventy-three times a minute, how many times does it beat in an hour? in a day? in a year?

3. The heart is said to do work equivalent to raising ninety-two and four hundred and twenty-five thousandths tons one foot high in twenty-four hours. How many feet could the same force raise one pound of blood in a minute?

4. How can we tell the difference between a vein and an artery that is near the surface?

5. Which way does the blood flow in the arteries? in the veins?

6. When a blood vessel is ruptured, how can we tell whether it is an artery or a vein?

7. If a vein is wounded in one of our limbs, how may the flow of blood be stopped?

8. On which side of the wound should the band be placed?

9. In case an artery is wounded, where should the band be placed? Why?

10. When an accident occurs, and blood is flowing freely, what should we use as a band?

11. How can we draw the band tight enough to stop the flow of blood?

12. If the wound is on the head, neck, or trunk, what is to be done?

13. In case of serious wounds, what next is to be done after stopping the flow of blood?

14. When blood flows from the veins, what change in it takes place from exposure to the air.

15. How does this change affect the flow of the blood from small veins?

16. Why do some beer and wine drinkers bleed more freely from a small wound than they would if their blood were in a healthy condition?

17. What forces besides the heart beat assist in the circulation of the blood?

18. How does a reclining position relieve the heart?

19. In its effect upon circulation, how does the work of a farmer compare with that of a clergyman?

20. How does the work of a cook compare with that of a sewing girl in its effect upon the heart?

21. How may a person whose business confines him to a sitting posture relieve his heart of extra work, and so preserve his health?

22. Why should clerks in stores be permitted to sit a portion of the time?

23. In regard to circulation, to what particular danger are conductors on railroads exposed?

24. When attending school, what should we do to promote circulation?

25. Why is exercise out of doors usually better for health than exercise in the schoolroom?

26. If a person is found exhausted, with his skin pale and cold, what is the trouble as regards circulation? What is the remedy?

27. When a sudden chill drives the blood away from the surface, what should be done at once?

28. What are some of the common causes of chills?

29. What are some of the ways of stopping persistent bleeding at the nose?

30. When persons faint, in what position should they be placed, and what remedies should be applied?

31. What may alcohol in the blood do to the arteries?

32. What does it do to the nerves in the walls of the blood vessels?

33. How does this cause them to hold more blood than they should?

34. What evidence of this do we see in the face of the drinker?

35. Why does the surface of the body feel warm after an alcoholic drink has been taken?

36. To what belief has this led respecting alcohol and cold?

37. How long does this feeling of warmth last?

38. What is the cause of the feeling of warmth?

39. Why does the person soon grow colder than he would have been without the drink?

40. What evidence can you give to show that cold can be better endured without alcohol than with it?

41. In what way can we avoid the red blotches on the skin which come from the use of "strong drink"?

TOPICAL ANALYSIS OF CHAPTER VII.

How the Blood nurtures the Body.

Waste and Repair.
1. Action wears out tissue.
2. The blood the agent of repair.

Channels of Circulation.
1. The arteries: structure — the aorta — branches.
2. The capillaries: size — extent.
3. The veins: structure — termination.

Action in the Heart.
1. From lungs to left auricle.
2. From auricle to left ventricle.
3. From ventricle to aorta.

Action in the Arteries.
1. Where the arteries are placed.
2. Jets of blood with each heart beat.
3. Elasticity of the walls of the arteries.
4. The pulse, and what it indicates.

Action in the Capillaries.
1. Worn-out particles are removed.
2. New particles are deposited.
3. The color of the blood is changed.

Action in the Veins.
1. The current flows evenly.
2. The valves open toward the heart.
3. Muscular action assists the blood flow.
4. Varicose veins.

Alcohol in the Blood.
1. Does not become a part of the blood.
2. Causes red blood corpuscles to shrink.
3. Deprives the blood of oxygen.
4. Interrupts repair.
5. Gorges minute arteries with blood.

Alcohol and Cold.
1. Sends the blood to the skin.
2. The blood is thus cooled very rapidly.
3. Those who do not use alcohol endure cold better than those who do.

Hygiene of the Circulation.

Something to find out.

CHAPTER VIII.

How the Body is Able to move.

Motion Necessary to Life.— In finding out how the body is nourished, we have seen that motions are required. To get and prepare the food which the body needs, we must make many movements of the arms, the legs, and various other parts of the body. To chew the food, we must move the jaws. The rings of the esophagus must successively contract, in order to force the food into the stomach. The stomach must keep up a vigorous action, in order to churn its contents into chyme. The heart must keep on contracting and expanding, in order to send the blood through the arteries to the various parts of the system. The movements by which breathing is carried on must never cease. The head must move in various directions, in order to pay attention to what is going on about it. In fact, the parts of the body are always in motion. Besides the motion which we notice, there are always going on within us many movements which we do not notice, but which are necessary to our existence; and, when there is no longer any motion in the body, we know that it is dead.

THE MUSCLES.

It is plain that the body must be provided with some means of producing all these motions, and, on examination, we find that the greater part of what we call flesh

is collected into bands, and so fastened to the various parts of the body as to pull them in the different directions required. These fleshy bands are called *muscles*. They are about five hundred in number, and have many different sizes, shapes, and lengths, according to the work they have to do. Besides their use in producing bodily motion, in which they may be compared to the ropes of a ship, they are so arranged as to give beauty and symmetry to the form.*

FIG. 16. — The muscles and tendons of the lower arm, showing also the ligament encircling the wrist.

General Structure of Muscles.—The steak which we eat for breakfast, and all the other lean meat which we have, is muscle. When we examine such a piece of meat, especially after it has been boiled, we find that it is made up of fibers, all extending in the same direction, and bound together by a thin membrane called *connective tissue*. When the fibers are placed under a microscope, they are seen to be composed of a collection of still finer strands, or threads. Some of the muscles are round, some are flat; some are not more than a sixth of an inch long, while others are more than two feet in length. Most of them have a large body, or *swell*, in the middle, and gradually grow smaller toward the ends; but a few are small in the middle and large at the ends.

Tendons. — Some of the muscles are joined directly to the bones upon which they act; but most of them be-

* The plumpness of the body is still further increased by the layers of fat with which the muscles are surrounded.

come smaller and tougher toward the ends, and at last terminate in strong, bluish-white cords, called *tendons*. The tendons are directly attached to the bones. They have no power of contraction. Wherever the tendons or muscles have a tendency to pull away from their positions, as at the wrist and the ankle, they are bound in place by stout bands, called *ligaments*.

Hollow Muscles.— Some of the muscles are not intended to connect one part with another, but form vessels to contain fluids. Such are the heart and the middle or muscular coat of the stomach, which have already been described.*

FIG. 17. — The left arm, showing the muscles in action.

How the Muscles act. — All the muscles have power to *contract* or become shorter; and, when the exciting cause is removed, to return to their ordinary forms. Those whose contraction is under the control of the will are called *voluntary* muscles. Such are those by which the motions of the limbs are produced. Those which contract without any conscious action of the mind, as the heart and the stomach, are called *involuntary* muscles. Some, like those which enable us to breathe, usually act of their own accord, but may to a certain extent be influenced by the will. Many of the muscles are arranged in *pairs*, one causing motion in a certain direction, and the other causing motion in the opposite direction.

* The muscular fibers of the blood vessels, of the lymphatic vessels, of the alimentary canal, of the ducts of the glands, and of the iris of the eye, are so arranged as to form hollow muscles.

When there is a great variety of motions in a single joint, or in any organ, each distinct movement requires a separate muscle. The swing of the arm at the shoulder, the roll of the eye, the twisting of the wrist and of the ankle, are examples of this arrangement. The contraction of muscles attached to bones gives motion to the limbs, the trunk, and the head. The action of the hollow muscles gives the motions necessary to carry on the work of the internal organs and for the circulation of the blood.

FIG. 18. — The muscles of the legs, as in the act of walking.

How the Muscles gain Strength. — We have already seen how the blood carries off the worn-out tissues of the body, and leaves in their place new material to repair the waste. The muscles are thus nourished by the food in the same manner as the other parts of the body. But Nature has also provided that those parts of the body which work the hardest shall have the most help and the most abundant nourishment. So, whenever a muscle is used a great deal, the blood carries to it an unusual amount of material to make and to keep it strong. It therefore happens that those muscles which are used most become largest and strongest.*

* The arm of a blacksmith is used so much and so vigorously that its muscles become, not only much larger than those of an ordinary per-

The Muscles need Rest.— So long as the muscles are in motion they are wearing out. To give time and opportunity for the repairs which are needed and which Nature desires to make, the motion of the muscles must cease from time to time. After we have used any muscle a proper length of time, it becomes exhausted. This is Nature's signal that it has done enough, and needs to be repaired. When a muscle is thus weakened and Nature has given the signal for rest, it is just as unwise to use it as it is to use a bridge which has been pronounced unsafe, or a rope with broken strands. Its use may perhaps continue for a time without serious consequences, but it may result in permanent injury of the weakened part, and possibly the death of the offender.

"Exercise for Health, not for Strength." — It is the duty of every person to be as healthy as possible, and to so train the body that it can carry out the directions of the mind. Therefore, any kind or amount of exercise that will keep the whole body fresh and vigorous is desirable; but any kind or amount of training that is designed to develop one part of the body at the expense of the rest, solely for the purpose of display, should be discouraged. The amount of vitality at our disposal, and our capacity for work, may probably be increased by judicious exercise; but there seems to be a limit to this increase. If we perform exhaustive bodily labor, the mind can not have so large a share of our vitality as would otherwise be the case. On the other hand, long and vigorous action of the mind exhausts so much of our vital power that the body can not be so active.

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son, but also much harder. The same is true of those who practice rowing, or who engage in any business requiring unusual muscular effort.

This inclination of Nature to give the most help to the part that is working hardest or has the most to do, is the reason why we should not try to do any bodily or mental work immediately after a hearty meal, as the vital powers are then needed in the processes of digestion. For the same reason *we should not eat more than we need;* for, if we do, so much vitality will be spent in digestion that we can not do the bodily or mental work of which we would otherwise be capable.

Effect of Alcohol on the Muscles.— Muscles, as we have seen, consist of fibers of lean meat; fat meat will not contract as muscle does in moving parts of the body. The lean muscles of those who drink alcoholic liquors, especially beer, often become *changed into fat*, or fatty globules are deposited so thickly in between the layers of muscles as to crowd and weaken them. One reason for this accumulation of fat in wrong places is an insufficient supply of oxygen in the tissues. The fat is not there changed as it should be by the oxygen to furnish heat and force to the body. We have seen that alcohol in the blood is capable of diminishing the supply of oxygen by injuring the oxygen carriers, i.e., the little red blood corpuscles.* In proof of this, the blood of a person who drinks beer, or other alcoholic liquors, is often found, upon analysis, to contain a much larger proportion of fatty globules than the blood of those who do not take these drinks.

If a drinking man should measure the strength of his muscles, that is, the weight he can lift before and after an alcoholic drink is taken, he would find he could lift less

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* Dr. Flint, in his well-known work on the "Theory and Practice of Medicine," says (page 54): "The accumulation of fat in the organism is the result of incomplete oxidation. . . . The use of alcohol favors the accumulation of fat by diminishing its normal oxidation."

after the dram than before. He may think he can lift more, but the test will prove that he can not. The tipsy man often boasts of his strength until his limbs are scarcely able to sustain him, because the alcohol has so deadened his nerves of feeling that he does not know his real condition.

Numerous experiments have proved that alcohol does not render people better able to endure severe labor or hardships, as some have supposed. On the contrary it reduces the power of endurance.*

An English physician who had watched the effect of alcohol upon soldiers during a campaign said: "Alcohol is injurious to soldiers while on the march, the reviving effect passing off after, at the utmost, two and a half miles have been accomplished, and being succeeded by languor and exhaustion as great or greater than before." An eminent American doctor, associated with the United States Army during the recent war, says: "The men who drink spirits habitually are the first to fail when strength and endurance are required, and they are less likely to recover from wounds and injuries."

Tobacco also injures the Muscles. — Both alcohol and tobacco impair the steadiness and precision of muscles that are necessary to do fine and good work. You will see the reason for this, when you come to study about the nerves

* A soldier in India one day missed, for some reason, his usual allowance of rum, in the middle of the day's march. Upon reaching their halting place at night he found, contrary to his expectation and that of his comrades, that he did not feel as much exhausted as usual. The next day, he and several of his mates tried going without their rum until night, and found that they felt much better than usual. They therefore continued the practice of reserving their rum until night, after the day's march was over. They had not yet learned enough about the nature of alcohol to give it up entirely, but they had found out by experience that they could march better without it.

that control all muscular motions, and the effect tobacco and alcohol have upon them. Proofs of these injurious effects can be seen in the shaking hand of the drinker and the weak and unsteady muscles of most boys and young men who use tobacco. Prof. Oliver, head of the drawing department in one of the naval academies, says that he can invariably recognize the user of tobacco by his tremulous hand in using a pencil and "his absolute inability to draw a clean straight line." A distinguished American author says: "No smoker who ever trained severely for a race or a game needs to be told that smoking reduces the tone of the system and diminishes all the forces of the body. He knows it."

HYGIENE OF THE MUSCLES.

I. We should eat plenty of wholesome food, in order that the muscles may be kept strong.

II. We should exercise all the muscles of the body, so that they may become strong and healthy.

III. We should exercise all the muscles frequently, to quicken the flow of blood in the veins, so as to take off some of the strain from the heart.

IV. We should not exercise to such an extent that all the vital forces of the body are used up in muscular action.

V. Any kind of exercise may become more injurious than useful, if it is allowed to overstep the bounds of moderation.

VI. After each period of activity, the muscles need rest — daily rest after daily toil, and a long period of rest after the exhaustive strain of long-continued work.

VII. We should carefully avoid all habits of posture, movement, or dress that will interfere with the free development and action of all the muscles.

VIII. In sitting, we should always keep the body as nearly erect as we can without special inconvenience.*

FIG. 19. — Improper and proper positions in sitting.

IX. All the movements of the body should be as graceful as possible, in order that they may be agreeable to others.

X. Calisthenics and gymnastics are well adapted to give grace to the movements of the body, and also furnish excellent exercise for young persons. They should, therefore, be generally used in schools.

XI. With all their other exercise, children need plenty of active play to keep their muscles in a healthful condition.

XII. All kinds of athletic sports and manly exercises

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* We can accustom ourselves to sitting erect by always being careful to sit well back on a chair, and not upon its edge, as the latter position distorts the spine and produces *round shoulders*.

that are not actually dangerous should form a part of every boy's education.

FIG. 20. — Proper and improper positions in standing: 1, a vertical line; 2, the spinal column.

XIII. Lawn tennis, croquet, horseback riding, or similar exercises, should form a part of the life of every girl who is not otherwise provided with active physical employment.

XIV. When work distorts the body by giving excessive exercise to the muscles that throw the shoulders forward, we should remedy the evil by purposely exercising the muscles that draw the shoulders back.

XV. We should avoid the use of beer, because it has a tendency to turn healthy muscle into fat.

XVI. When in health, we should avoid the use of all alcoholic liquors and narcotics, as they tend directly to weaken the muscles and to diminish muscular action.

SOMETHING TO FIND OUT.

1. Why are the muscles of the right arm usually larger than those of the left?

2. Why are so many men, who work hard, round-shouldered?

3. In what way can the tendency to become round-shouldered be prevented?

4. What good comes from the practice of the game of baseball? What caution needs to be observed?

5. What is the effect of a tight band around a muscle?

6. When the fist is clinched, where do the muscles contract and become rigid?

7. Does the expansion as well as the contraction of a muscle upon one of the limbs produce motion?

8. Why is better exercise obtained by rowing than by walking?

9. Why is it wrong to keep children still for a long period at a time?

10. When children are restless in school, what are some of the probable causes?

11. What are some of the advantages to be gained by "going a-fishing"?

12. What is the best time for muscular rest?

13. Which will tire a horse more — to travel on a level road or on a moderately hilly one?

14. Why can not the arm hold out a weight for a long time?

15. Why should we not engage in active muscular exercise just before eating?

16. After a period of hard study, what kind of exercise should be taken?

17. In running, or other violent exercise, what peculiar symptom tells us when to stop?

18. What is the consequence if we do not obey the command?

19. What is the best employment for the half hour before going to bed?

20. When a boy or a girl is not really ill, what do stooped shoulders and a shuffling gait indicate?

21. Why does going half a mile on an errand sometimes tire a boy more than walking five miles to see a circus?

22. If a person is free to choose his work, what principle should guide his choice?

23. Of what do the muscles consist?

24. Why will not fat answer the purpose of the lean fibers in moving parts of the body?

25. What change does beer drinking often make in the muscles?

26. What reason can you give for this?

27. How has the blood of habitual drinkers been found to differ from the blood of people who do not use alcoholic drinks?

28. How do alcoholic drinks affect the strength of the muscles?

29. Why does the tipsy man boast of his strength?

30. What effect does alcohol have upon those who have to endure hardships?

31. What evidence on this point is to be found in the experience of soldiers?

32. How do alcoholic drinks affect the steadiness and precision of the muscles?

33. How does tobacco smoking affect a boy's ability to make a "clean straight line"?

34. What is always forbidden to those who are training for a race, or other athletic sports?

TOPICAL ANALYSIS OF CHAPTER VIII.

How the Body is Able to move.

Motion Necessary.
1. The motion of the body and its parts indicates life.
2. Want of motion is the sign of death.

The Muscles.
1. The muscles produce motion and give beauty to the form.
2. General structure: connective tissue — shapes — hollow muscles — tendons — ligaments.

Muscular Action.
1. Contraction and expansion.
2. Voluntary and involuntary action.
3. Peculiar movements.

Care of the Muscles.
1. Repair of muscles.
   1. The blood supplies nourishment.
   2. Muscles most exercised receive most nourishment.
2. Exercise of muscles: work — games — calisthenics.
3. Rest of muscles: after exercise — after injury.
4. Proper position: in sitting — in standing.
5. Dress must leave the muscles free.
6. Agreeable occupation lightens labor.

Exercise.
1. Exercise should be for health.
2. The body should serve the mind.
3. Muscular development not for display.
4. Exercise should not exhaust the energies.

Alcohol and the Muscles.
1. Alcohol changes muscular fiber to fat.
2. Weakness of a drunken man.
3. Soldiers endure more without alcohol.

Tobacco and the Muscles.
1. Tobacco makes the muscles unsteady.
2. Diminishes strength.

Hygiene of the Muscles.
Something to find out.

CHAPTER IX.

How the Body is Able to stand.

The Need of a Bodily Frame. — If the body were made up entirely of soft materials like the muscles, it might be capable of motion in its different parts and some movement as a whole. But it would not be able to stand erect, or to retain any permanent shape. Its beautiful proportions, its graceful motions, and its dignified bearing would all be impossible; and a human being would be nothing more than a mass of flesh physically inferior to almost every other animal in existence. That it may be able to stand erect and keep its proper form, the body needs a strong and solid framework. This is furnished by the *bones*.

THE BONES.

Uses of the Bones. — The bones have three distinct uses. 1. They give shape and strength to the body, and keep the various parts and organs in position. 2. They protect organs which would otherwise be exposed to injury. 3. They afford a solid place for the attachment of muscles by means of which motion may be given to the various parts of the body.

Forms of Bones. — In order to meet these requirements, the bones are of different sizes and shapes, and are arranged in the various ways best suited to the purposes for which they are designed. Those whose chief use is

to protect are made strong and thick, and of such shape as to offer most resistance with the least material. Where several bones unite to protect any organ, they are placed around it in such a manner as will defend it most effectually. Those whose chief use is to furnish support to the body, or a firm part to which other portions are fastened, are very thick and solid, and of such shape as will best adapt them for staying in place. Those designed to strengthen upright portions of the body, or to produce motion, are long and straight. Others, which have more than one of these offices to perform, are so ingeniously constructed that they combine two or more of these features.

Structure of the Bones. — The long bones, which form the framework of the limbs, consist of a slender shaft of hard, compact material, and have enlarged extremities composed of a softer, spongy material.* The shaft is hollow in the middle, and contains *marrow*. This is composed chiefly of blood vessels and fat, and supplies the bone with nourishment. The other bones are spongy inside, and hard and fine in texture on the outside.† The bones are covered with a tough, fibrous membrane, ex-

FIG. 21. — Upper portion of the right femur, sawn in two lengthwise, showing the difference of texture between the shaft and the extremity.

* The increased size and the spongy character of the extremities furnish better attachments for the tendons, and the increase in size makes up for the decrease in hardness.

† The bones are full of fine tubes from $\frac{1}{200}$ to $\frac{1}{2000000}$ of an inch in diameter. Through these the blood passes to carry on the work of repair, as in the other portions of the body.

cept at the joints, where they are covered with *cartilage*. If this fibrous membrane is removed, the bone dies.

Materials of which the Bones are made. — When a bone has been burned for a sufficient length of time it will be so brittle that it can be easily broken. If it be soaked in diluted muriatic acid it will entirely lose its stiffness, and, if of sufficient length, can be tied in a knot. By these experiments it will be seen that the bones contain a mineral or earthy substance, which makes them stiff and hard, and a certain amount of animal matter or *gelatin*, which binds them together and gives them a slight degree of elasticity. The earthy substance is mostly *lime*, and composes about two thirds of the weight of the bone.*

In childhood the bones are more largely composed of animal matter than in old age. On this account, children are less likely to have their bones broken by blows and falls; but, for the same reason, they are more likely to become deformed by remaining in an improper position. The legs of young children are often bent out of shape by too much use of them before their bones are firm enough to support the weight of the body. In old persons the bones are so brittle as to break very easily, and when broken they do not readily unite again.

Growth and Repair of the Bones. — The bones do not reach their full development before the age of twenty-five, and in persons who use the brain a great deal the skull is said to continue its growth much longer. The continual repair of worn-out parts is carried on in the

* The color of bone in the living person is a pale-rose tint, inclining in early life to red, in old age to a yellowish white. Bones assume a beautiful white when deprived of the oily fluids which pervade them. The specific gravity of fresh bone is greater than that of any other animal substance.

bones as in the rest of the body.* In order that bones may be strong and healthy they *must be nourished by good blood*, having in it the materials out of which bone is built up. Alcohol, by its injurious effects upon the blood, prevents, in many cases, the proper growth and healthy condition of the bones. Tobacco also interferes with the nourishment of the bones and in many cases checks their growth.

When a bone is broken and the parts are brought together again, a jelly-like substance is poured out of the fractured ends until the break is closed by a gristly formation. In due time, mineral matter is supplied to stiffen the gristly matter thus provided, and the bone is finally restored to its original form and strength.

Bones of the Head. — The bony case which gives shape to the head, and protects the brain lying within, is the *skull.* It is smaller and stronger in front than behind, and rounded or oval on top, so that its form is much like that of the upper half or three quarters of an egg, as it appears when lying at rest. In front and on the sides it has *sockets* for the eyes and *passages* for the nose and the ears. The skull is composed of two compact armor-like plates, with a layer of spongy bone between them. The dome-like top is the best possible form for resisting pressure or blows, and the spongy layer tends to prevent the jar of a blow being felt by the brain. The *upper jaw* and the bones of the nose and the cheeks belong to the skull, to which they are firmly attached. The mouth is opened and shut by means of the *lower jaw.*

Sutures of the Skull. — The skull is made up of several

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* If any red coloring matter, such as madder, be mixed with the food of a young animal, its effect will appear within a day or two in the changed color of the bones.

parts joined by irregular, saw-like projections and depressions on each side, very much as we can lock the fingers of our two hands together. In childhood the parts of the skull are not very firmly united, but as the person grows older the union becomes more and more complete. The use of having the skull in several parts is to allow the brain to grow and to prevent a jar from affecting the whole skull.

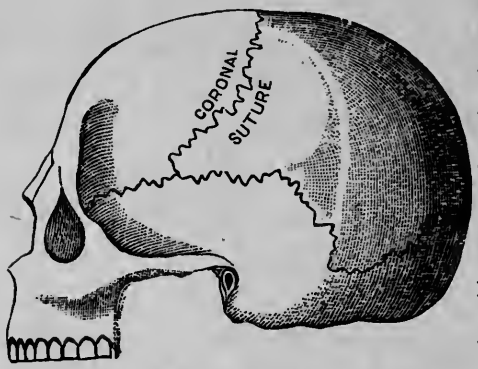

FIG. 22. — The skull, showing the sutures.

Bones of the Trunk. — The bones of the trunk are the pelvis, the spinal column, the ribs, the breastbone, the shoulder blade, and the collar bone.* The *pelvis* is situated at the bottom of the trunk, and gives shape to that part of the body. It furnishes a solid part upon which the spinal column may rest to support the upper part of the body, and is itself supported upon the large bones of the *thighs*, or upper parts of the lower limbs. It is thus one of the most important parts of the framework of the body. It is formed of four large bones firmly united and arranged in the form of a basin.

Attached to the pelvis, and extending up the middle of the back to the head, is the *spinal column*, or backbone. It is made up of twenty-four small, flat bones

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* Strictly, the shoulder blade and the collar bone form a class by themselves. "The Upper Extremity consists of the Arm, the Forearm, and the Hand. . . . The Shoulder is placed upon the upper part and side of the chest, connecting the upper extremity with the trunk; it consists of two bones, the Clavicle and the Scapula." (Gray's "Anatomy.")

called *vertebræ*,* placed one upon another with a pad of rubber-like cartilage between each two. The spine is the main connecting structure of bone in the body. It holds the trunk in position, and contains a channel through which passes the spinal cord, which, next to the brain, is the most important part of the nervous system.†

FIG. 23. — The pelvis, showing the hip joint and the relative positions of the spine and the femur.

The *ribs*, twenty-four in number, are in pairs inclosing the chest. They are attached to the spinal column by a kind of joint which allows them to move up and down enough for the purpose of breathing. In front the upper seven pairs are attached to a strong, flat bone extending up and down and called the *breastbone*.‡

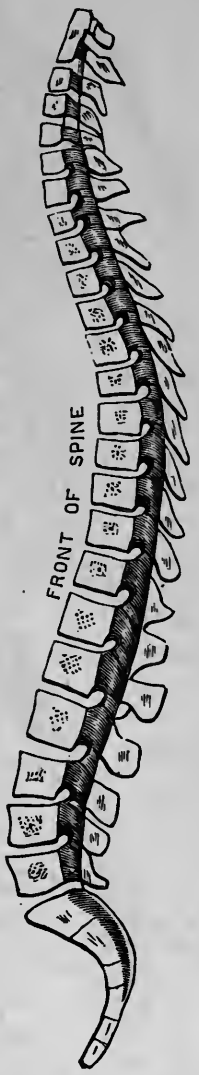

FIG. 24. — The spine or spinal column.

* Of the vertebræ, seven belong to the neck, twelve to the back, and five to the loins. The *sacrum* and the *coccyx* are consolidated vertebræ, and may be included in the spinal column.

† When we look at the spine from the side, we see that it has a double curve, bending back from the neck to the shoulders, then forward to the waist, and then back as it nears its lower extremity. A *pivot joint* connects the two upper vertebræ, and a hinge joint connects the vertebræ with the skull, enabling us to turn the head and move it backward and forward.

‡ The lowest two on each side are not attached in front, and are called *floating ribs*. The remaining three pairs are connected by bands of cartilage, and are called *false ribs*.

Extending downward from the top of the trunk behind the arms, on each side of the spine is a strong plate of bone, shaped like a triangle and called the *shoulder blade.* From the part of the shoulder blade nearest the arm to the upper part of the breast-bone, extends a slender bone shaped much like the italic *f*, and called the *collar bone.* This braces the shoulder blade and helps to keep it in place.

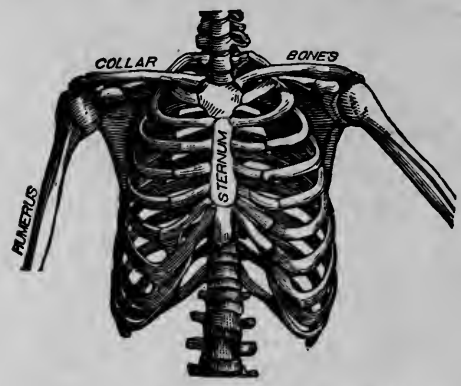

FIG. 25. — Bones of the thorax, showing the shoulder joint, the relative positions of the spine and bones of the upper cavity of the trunk, and the shape of the ribs in a healthy chest.

Bones of the Arms. — The bones of the arm consist of a single long bone between the shoulder and the elbow; two between the elbow and the wrist;* eight in the wrist; five in the palm of the hand; and the bones of the fingers and thumbs which can be readily counted.

FIG. 26. — Bones of the right arm, showing their ordinary positions.

Bones of the Legs. — The bones of the legs correspond almost entirely to those of the arms — a long one between the trunk and the knee; a small bone which protects the knee-joint; two bones between the knee and the ankle; seven in

FIG. 27. — Bones of the left arm, showing the ulna and the radius in a twisted position.

* Of these two the *ulna* is the one more closely joined to the *humerus.* The *radius* is more closely joined at the wrist, and moves around the ulna.

the ankle; and five in the body of the foot. The bones of the toes, like those of the fingers, can be easily counted.

Arch of the Foot. — The bones of the foot are arranged in such a way as to form an *arch*. When the weight of the body is thrown upon the foot, as in walking and leaping, the top of the arch is pressed downward, and the bones spread outward, making the foot wider than before. In this way the body is preserved from shocks which would otherwise greatly injure it.*

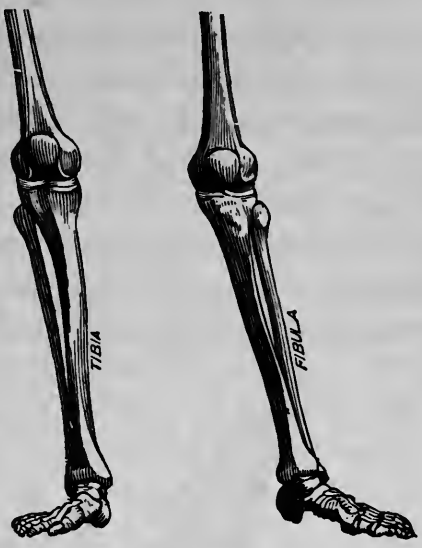

FIG. 28. — Bones of the legs in their relative positions.

Bony Cavities of the Body. —The cavities of the body which are formed and protected by the bones are now seen to be the skull, the chest, and the abdomen. The skull contains the brain, which is the most sensitive organ, and has no motion. Hence the skull is absolutely unyielding. The chest not only protects the organs within, but varies in size to accommodate the lungs in breathing. Accordingly, it is not only strong, but is made so that it can expand. The pelvis supports the organs of

* Tight shoes, and shoes made of coarse, heavy leather, are injurious in many respects. They prevent the spreading of the foot, and change the act of walking from a free, springing motion, to a stiff unnatural gait. The bones become distorted and overlap one another, producing permanent deformity. The continued pressure upon the flesh produces *corns*, *bunions*, and *ingrowing toe nails*. High heels throw the weight too far forward, and heels placed under the hollow of the foot not only prevent the spring of the arch, but quickly produce deformity.

digestion, and for this purpose is shaped like a basin. It also sustains the body on the pillars formed by the legs. It is, therefore, thick and unyielding.

BODILY MOVEMENTS.

How the Muscles move the Bones. — The cause of motion in the body is the *contraction of the muscles.* In the hollow muscles the result of contraction is to diminish the capacity of the vessels which the muscles form. Where the muscles connect two bones, the contraction draws the connected bones toward each other. The lower jaw is drawn upward by a strong muscle attached to the cheek bone, which acts directly to bring the jaws

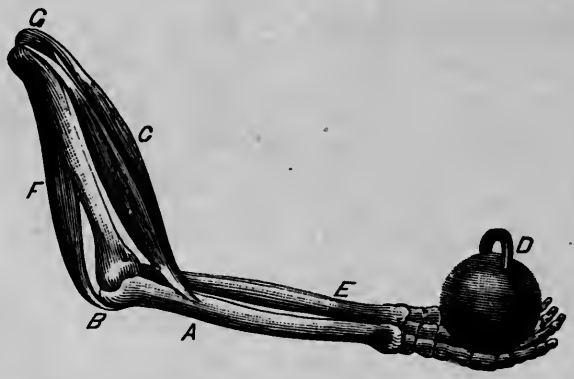

FIG. 29. — The arrangement of bones and muscles by which the arm is bent: *A*, the radius; *B*, the elbow; *C*, biceps; *E*, ulna; *F*, triceps; *G*, shoulder joint.

together. The arm is bent by a strong muscle called the *biceps.* This is attached at one extremity to the shoulder blade, and at the other to one of the bones just below the elbow.* The opposite movement, by

* When the biceps contracts, the bone below the elbow (the radius) is drawn upward toward the shoulder; but, as the tendon of the biceps is attached to the radius so near the elbow, it plainly requires more muscular effort to bend the arm than would be required were the tendon of the biceps attached nearer the wrist. The enlargement of the elbow

which the arm is straightened, is caused by a similar muscle on the opposite side of the arm. The muscle which throws one leg across the other reaches from above the hip on the outside to below the knee on the inside, and is called the *tailor's muscle*, because it is the one which a tailor uses in taking his peculiar position on the bench. Wherever a twisting motion is to be produced, there is a similar arrangement. A rotary movement of the eyeball is produced by a muscle passing through a pulley-like loop.

How Shocks are distributed. — Every one knows that, when a person needs to jump from a high place, the *shock* felt will be much less if the body is allowed to bend freely than if it is kept rigid. The hand of a catcher who wishes to feel the sting of the ball as little as possible is allowed to move backward when the ball is caught. It will be readily seen that, if, in these cases, the limbs were held rigidly in a straight line, the firm ends of the bones could not fail to strike heavily against each other, much as the buffers of two railway cars do when the cars collide. But when the joints are bent and the muscles are relaxed, the main force of a shock is expended in further bending the joints, and the shock felt by the limbs in the direction of their length is very slight.

In jumping, if we strike upon the toes, the shock is first moderated by the arch of the foot, which acts like a spring. The force of the shock is further distributed at the ankles, the knees, and the hips, by the three curves in the spine, and lastly at the joint which connects the spine with the skull.

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joint, by raising the tendon away from the arm, brings it more nearly at right angles to the radius, and thus gives it more effect in bending the arm than it would have were it parallel to the radius.

Injuries to be avoided. — The bones are often *broken* or *put out of joint* by falls, sudden blows, etc., or bent out of shape by improper positions or long-continued pressure. *Curvature of the spine* may be caused by keeping one shoulder higher than the other, as by habitually resting one arm higher than the other on a desk at school. Of the same nature are *deformed waists*, and the *deformities of compressed feet.* Pulling the joints apart "to make them crack" is also a dangerous practice.

HYGIENE OF THE BONES.

I. The food and drink that we take must contain enough lime to nourish the bones.*

II. In childhood, before the bones harden, they should not be made to bear heavy burdens or endure any severe or long-continued pressure or strain.†

III. Exercise, giving the proper amount of pressure and strain, is necessary to promote the growth and nurture of the bones.

IV. The bones of the foot should not be compressed so as to prevent the free spring of the arch and the spreading of the bones, when the foot is called upon to sustain the weight of the body.

V. No tight clothing or tight bands should be worn about the ribs or waist. They interfere with the movement of the bones in breathing. ‡

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* Farmers have long noticed that cattle often do not thrive in an old pasture. Their bones become tender and are easily broken, and the whole body suffers in health. The reason is that those elements of the soil that make bones have been used up, and the remedy is to supply fertilizers that contain lime.

† A baby's legs are often made crooked by trying too early to make it walk. In school, many a child has been deformed by sitting on so high a bench that its feet could not touch the floor.

‡ The errors in woman's dress are: 1st. The corset which reduces

VI. We should sit and stand erect, so as to prevent the distortion of the bones which comes from the habit of bringing the shoulders forward and bending the head down.

VII. We should avoid resting one arm higher than the other, as this practice tends to produce a permanent curvature of the spine.

VIII. When a bone is injured or a joint sprained, we should keep perfectly quiet until the part is fully recovered.

SOMETHING TO FIND OUT.

1. What are the appearance and composition of a bone after it has been thoroughly burned?

2. What are the appearance and condition of a bone after it has been soaked in diluted muriatic acid?

3. In making soups, what ingredient is derived from the bones, and how is this ingredient obtained?

4. What is the comparative effect of a sudden blow upon the bones of young and of old persons? What is the effect of pressure?

5. When bones are broken, what are some of the conditions necessary for their repair?

6. In what plays is there particular danger of getting bones broken?

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the waist from three to fifteen inches, and pushes the organs within downward.

2d. Unequal distribution. While her chest and hips are often overloaded, her arms and legs are so thinly clad that their imperfect circulation compels conjestion of the trunk and head.

3d. Long, heavy skirts, which drag upon the body, and impede the movements of the legs.

4th. Tight shoes, which arrest circulation, and make walking difficult. High heels, which increase the difficulties in walking, and so change the center of gravity in the body as to produce dislocations in the pelvic viscera. (Dr. Dio Lewis.)

7. Why is the skull at the top rounded in the shape of a dome?

8. What animal is so constructed that it appears to throw back its upper jaw?

9. Why are the bones of the pelvis large and very strongly constructed?

10. What is the use of the rubber-like cartilages between the vertebræ of the spinal column?

11. After a day of active exercise in work or play, why are we shorter than when we first arose in the morning?

12. What effect does wearing a tight band around the waist have upon the shape of the ribs? upon the movement of the ribs? upon the movement of the diaphragm? upon breathing? upon the position of the organs of the chest and abdomen? upon the circulation of the blood?

13. Why should the soles of shoes be broad? Why should the heels be broad and low? Why should the upper leather be soft and pliable?

14. Why do people wear tight clothing and tight shoes?

15. What reason is there for making shoes with high heels, or with the heel in the hollow of the foot?

16. In what way are corns produced?

17. What name is applied to the lower limbs when the bones have become permanently bent?

18. In the bones of the lower arm, which bone is attached at the elbow, and which at the wrist?

19. When you saw in two, lengthwise, a beef or mutton bone taken out of the leg, how does the interior appear?

20. Why are the bones and joints of the toes so frequently deformed?

21. Why does a person in catching a ball draw his hands back the moment the ball touches them?

22. Why do we strike on the ball of the foot when we jump?

23. Why, in walking or jumping, is it best to keep the joints bent?

24. When we unexpectedly step down a few inches, what effect is produced? Why?

25. Why do so many people have a stiff, awkward gait?

TOPICAL ANALYSIS OF CHAPTER IX.

How the Body is Able to stand.

The Need of a Bodily Frame.
1. To enable the body to stand erect.
2. To keep the body in proper form.

The Bones.
1. Uses of the bones.
   1. To give shape to the body.
   2. To protect delicate organs.
   3. To afford attachment for muscles.
2. Forms of the bones.
3. Structure of the bones.
4. Materials: animal matter — mineral matter.
5. Growth and repair.

Distribution of the Bones.
1. Bones of the head: skull.
2. Bones of the trunk: pelvis — spinal column — ribs — breastbone — shoulder blade — collar bone.
3. Bones of the arm: the wrist bones — the hand.
4. Bones of the legs: ankle — foot — arch of the foot.
5. Bony cavities: skull — chest — pelvis.

Bodily Movements.
1. How produced.
2. How shocks are distributed.

Care of the Bones
1. Proper food.
2. Suitable exercise.
3. Moderate exercise in childhood.
4. Proper positions.
5. Easy clothing.
6. Shoes of proper form and material.
7. Rest after injury.

Hygiene of the Bones.

Something to find out.

CHAPTER X.

How the Body is covered.

The Usefulness of the Bodily Covering. — Every one who has had a piece of the skin torn off, can understand how important it is that there should be a covering for the muscles and other sensitive organs which lie near the surface of the body. Besides the pain caused, the removal of the skin allows poisonous or irritating substances to enter and injure the body. In addition to the protection which it gives, there are many other offices which the skin performs. It helps in removing waste matter from the system, absorbs matters brought in contact with it, serves as the organ of the sense of touch, aids the lungs in taking in oxygen and giving out carbonic acid, helps to regulate the heat of the body, and, in general, not only defends the organs within, but helps them when they are unable to do their full amount of work. It also, with the hair and its other appendages, does much to beautify the person and give expression to the emotions and the thoughts.

THE SKIN.

General Structure of the Skin. — The thickness of the skin varies in different parts of the body. Where it is much exposed to wear, as on the soles of the feet or the palms of the hands, it becomes very thick and is called

a *callus*.* In other parts it is very thin and delicate. At the ends of the fingers and the toes, where unusual protection is required, it grows into shield-like plates called *nails*. On the scalp, where special protection of the brain is needed, it puts forth a thick covering of *hair*.

Layers of the Skin. — The skin is divided into two principal layers. The outer one is called the *scarfskin* or *cuticle*. It is made up of little cells flattened into scales. It has no blood vessels or nerves, and may be cut or pinched without giving pain. As the cells near the surface become dry and hard from lack of nourishment, they fall off and new ones from beneath take their place.† The lower part of the scarfskin contains the *coloring matter* to which the color or complexion of different races and different individuals is due.‡ The

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* When this thickened skin is at the same time continually subjected to hard pressure, as by tight shoes, it forms an excessively hard, horny lump called a *corn*. Any means of softening the lump, as soaking it in warm water, together with the removal of the cause will often remedy the evil.

† It is these worn-out cells, or scales, that separate from the skin in bathing. They also constitute the *dandruff* which forms on the head and comes off in small, white particles, especially when the hair is combed or brushed.

‡ When the amount of coloring matter in the pigment cells is very slight, it produces a *blonde* complexion; when greater, that of a *brunette*. The colors of the different races depend upon the kind and amount of pigment in these cells. The amount of coloring matter is increased by exposure to heat and light. Every one knows that those who spend much time in the open air, especially in summer, become tanned or freckled, and that when winter comes again, or they remain in doors for a time, the tan and freckles mostly pass away. This is because the light and the heat increase the pigment. When this takes place in spots, it causes *freckles* only; when it affects the whole exposed surface, it causes *tan*.

When persons of a light complexion go from countries distant from the equator into the very warm regions between the tropics, they become almost as dark as the native inhabitants. When the natives of

inner layer of the skin is called the *cutis*, or *true skin*. The part of this nearer the surface is composed of little *elevations*, which contain blood vessels and nerves, and from some of which arise the *openings* through which

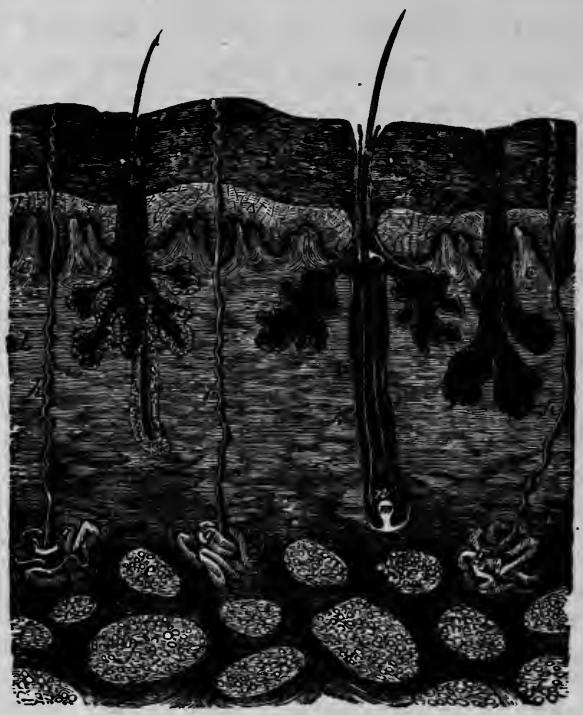

FIG. 30. — Vertical section of the skin, magnified: *a*, scarfskin; *b*, pigment cells; *c*, papillæ; *d*, true skin; *e*, *f*, fat cells; *g*, sweat glands; *h*, outlets of sweat glands; *i*, their openings on the surface of the skin; *k*, hair follicle; *l*, hairs projecting from the skin; *m*, hair papilla; *n*, hair bulb; *o*, root of hair; *p*, openings of oil glands.

the hairs reach the surface of the skin. Below these elevations lies the main part of the true skin; and between the true skin and the flesh is a layer of fat, which varies in thickness in different persons.

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very hot countries live for a long time in cooler latitudes, their complexion gradually becomes lighter. In some persons the pigment is entirely wanting. Such persons have a pallid complexion and pink eyes, and are called *albinos*.

How the Skin is kept Soft. — All over the surface of the body are little tubes which descend into the true skin, like the finger of a glove with the end downward. Some of these tubes end in little bags somewhat resembling clusters of grapes. These groups of bags collect *oil* from the blood and pour it out through the openings upon the scarfskin, to keep its cells from falling off too rapidly, and in this way the skin and the hair are kept soft and pliable.

How the Skin casts out Waste Matter. — In the layer of fat beneath the true skin lie the coiled ends of tubes, which reach to the surface of the skin. These filter off from the blood the perspiration, and are called the *sweat glands.** The perspiration consists chiefly of water, but contains also a certain amount of waste material. In this way the skin aids in keeping the body free from impurities.

Other Means of Casting out Waste. — A considerable part of the waste matter of the body passes off through the *kidneys.* These organs lie in the abdominal cavity, one on each side, just below the "small of the back." They absorb from the blood impurities which can not be expelled at the lungs. The waste which passes off through the kidneys and through the skin is much alike, and in their action they assist each other. When the

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* A magnifying glass will disclose on the ridges on the palm of the hand over three thousand openings of the sweat tubes in every square inch. There are also great numbers on the soles of the feet; and even where least numerous, as on the back, there are about four hundred present to every square inch of surface. Indeed, it has been calculated that there are twenty-eight hundred sweat glands, on the average, in every square inch of the body, making a total in an average-sized man of about seven million, which is equivalent to twenty-eight miles of the tubing, since each tube is a quarter of an inch long. ("The Skin and its Troubles.")

kidneys are diseased, the skin does more work; and when the skin is out of order, as from the effects of a cold, the kidneys become more active.

How the Skin regulates Heat. — It is a familiar fact that, in very warm weather, the heat of a room can be lessened by sprinkling the floor. This is because heat is used up in changing the water into vapor, and so is not able to increase the temperature. The same is true of the perspiration which is thrown out from the sweat glands. Usually the perspiration is poured out so gently that it is not noticed, and is said to be *insensible.** But, in very warm weather, or when the body is heated by exercise, it forms visible drops. The more rapidly the perspiration flows out, and is changed to vapor, the less we feel the heat.† But we need to drink much more, in order to keep a proper amount of moisture in the body.

How the Skin absorbs. — The true skin contains a great number of blood vessels,‡ which distribute nourishment to the roots of the hair, the oil glands, and the other parts of the skin; and which carry back the exhausted blood to the heart. It also contains, like other parts of the body, what are called *lymph vessels.* These seem to start out of the part in which they are found like the roots of plants in the soil, and gradually unite to form larger and larger tubes, emptying finally into the veins. With the

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* The insensible perspiration of an adult person amounts to about twenty ounces in twenty-four hours.

† It is on this account that a man may remain alive in an oven heated as high as 600°.

‡ The presence of red blood in these blood vessels gives to the skin its ruddy color. When from any cause the blood rushes to the skin, this ruddiness is increased. When this rush of blood is supposed to be caused by some emotion, the effect is known as *blushing.* When from any cause the blood is withheld from these vessels, its absence is known as *pallor*, or paleness.

exception of the lacteals, which form one class of lymph vessels, they carry a colorless fluid called *lymph*, which helps the blood in nourishing the body and carrying away waste matter. Whenever any substance soaks through the scarfskin, it is caught up by the lymph vessels and the veins, and is hurried away to various parts of the system.*

Why the Skin should be kept Clean. — It is plain that the natural waste of the scarfskin, and the pouring out of oil and perspiration from the glands, must result in the accumulation of much *impurity* upon the surface of the skin. It is plain, also, that if this mass of impurity is allowed to remain, it must not only be in itself offensive, but must derange the action of the organs of the skin. The amount of impurity thus thrown out of the body is much increased by any unusual excitement of the nerves caused by excessive emotion. Besides these collections, the dust and dirt which come upon the skin in the course of our ordinary work require frequent removal. If these impurities are not speedily removed, they derange the action of the skin, and, through the skin, diminish the comfort and capacity of the whole body.†

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* The power of the skin to absorb is illustrated by the fact that persons have been kept alive by baths of soup and other nourishment. On the other hand, it is well known that persons whose work compels them to handle poisonous substances frequently lose their health by continual contact with the materials used. Similar effects are sometimes produced by so slight a cause as a kiss from one who is affected by disease.

† Other animals show us the good of being clean: a badly groomed horse is never sound or spirited, and a dirty pig puts up one fourth less flesh than a clean one. Yet it may be feared that some human beings are only thoroughly washed at birth and at burial. (Mapother.)

Many an evil action is the remote result of a neglect of cleanliness. When it is habitual, it brings about a degraded state of mind; and even when it is temporary, its irritating effect upon the disposition is often noticeable. It is a fair question whether in many cases, a bad

How to keep the Skin Clean. — The only means of keeping the skin clean is frequent and thorough *bathing* of the entire body. This should be attended to every day, if possible. If from any cause this frequency is not possible, the nearest approach to it should be made. Under any ordinary circumstances, such a bath may be taken by every person at least once a week. Besides this bathing of the whole body, those parts which especially need it should be washed as often as any impurity is discovered upon them. For merely cleansing the body, tepid or warm water is the most effective. But such a bath is relaxing in its effect, and should not be used very often. The cold morning bath is very beneficial to perfectly healthy persons, not only for its cleansing power, but also for its stimulating effect. If a bath tub is used, a simple plunge will in most cases be sufficient. The most convenient and profitable morning bath within the reach of a majority of persons is the sponge bath. This requires only a basin of water, a sponge or wash cloth, and a towel. Only so much soap as is necessary should be used.

If the skin does not recover its warmth in a short time by vigorous rubbing of the body with a coarse towel, the person is not in proper condition to profit by cold baths. The other forms of bathing are either medicinal in their nature, or partake of the nature of luxuries.*

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boy might not be converted into a good one by means of a bath and a change of clothes. The public baths in many cities are really very important agencies in suppressing wrongdoing.

* Sea bathing is a very popular form of the natural bath, and it is preferable to bathing in river water or spring water, because the sea is seldom so cold as are the latter. A sea bath has also another great advantage over all other forms of bath, and that is that it is taken in the purest air possible; and in considering the effects of sea bathing, it is impossible to separate the effects of sea air from that of the sea

No kind of full bath should be taken within less than two hours after a hearty meal, because the process of digestion will not allow so much distraction of bodily energy. The soap used in bathing should not be very strong, because such soap will remove too much of the scarfskin, and, in cold weather especially, will cause the skin to *chap*.

Alcohol and the Skin. — The blood vessels of the skin, as we have seen, often become permanently enlarged by the continued use of alcohol. We can see these expanded blood tubes underneath the skin. They make what are often termed "rum blossoms" on the nose of the drinker. The blood flows through them sluggishly, and being poor in oxygen, and containing waste matter, it does not nourish the skin as it should. The outer or "scarf" skin remains on in dry scales, blocking up the openings of the oil ducts and sweat tubes. Then the skin can not properly perform its part in getting rid of waste matters, and the kidneys have to do more than their share, from which cause they often become weakened or diseased.

When blood containing alcohol reaches the kidneys they try to remove as much of it as they can, together with the other impurities which it is their duty to take from the blood. The alcohol which the kidneys try to remove causes irritation and inflammations which, if repeated often enough, produce serious diseases of these important organs. It is now admitted that a large propor-

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water. The sea bather is also constantly inhaling the spray of the sea water, and thus obtains whatever benefit is to be got in this way. If he can swim, he enjoys all the benefit of exercise. The motion of the water and the buffeting he gets from the waves act as a powerful excitant to the skin; and, lastly, the salt in the water adds considerably to the stimulating action. Reaction more readily occurs after a sea bath than after a river bath. ("Baths and Bathing.")

tion of kidney diseases are caused by the use of alcohol. Not those alone who use alcohol "excessively" are liable to diseases of the kidneys from the use of this drug. A small quantity of wine or beer, as we have seen, causes the little blood vessels in all parts of the body to become distended with blood. The person who takes three or four drinks every day keeps these blood vessels of the kidneys in a distended state much of the time. An English physician * says: "The result of this must be an injurious pressure of the distended blood vessels upon the tissues of the kidneys, which interferes with the proper nourishment, and also that it renders the organs more liable to the effects of chills, which are well known to be a fruitful cause of kidney disease."

THE HAIR.

What it is. — The hairs are modified forms of the scarf-skin. Human hairs are solid, but the central parts are made up of cells loosely packed together to form a *pith*. The *shaft* of a hair is the part outside the skin. The *root* is the part which lies below the surface. At the side of the hair are little muscles, by which it may be made to "stand on end." The color of the hair is due to a coloring matter in the cells. The flatter the hairs are, the more readily they curl.†

How to keep the Hair Healthy. — The health of the hair depends mainly on the general health of the body.

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* George M. Harley, "London Lancet," March 3, 1888.

† The hair upon the head and the face protects from cold, and shields the head from the rays of the sun in hot climates. It also breaks the force of a blow upon the head. The eyebrows prevent the perspiration from running from the forehead upon the lids. The eyelids protect the eyes from dust and other injurious matters. The short, stiff hairs of the ears and the nose are also for protection to these openings.

A slight, continuous shedding of the hair, especially in the spring and autumn, does not indicate ill health. The hair should always be kept clean by frequent *washing*, and by thorough but not rude *brushing*. Cutting the hair tends to promote its growth. Great care should be taken to keep the scalp from undue pressure from any cause, and any covering of the head which prevents the free access of air is to be avoided.

Thinning and Grayness of the Hair. — Whatever leads to weakness of the body will injure the hair. Sometimes early grayness, or the loss of the hair, is common in a family. Sometimes they result from a local disease of the scalp; but usually they indicate a general weakness of the body, or some overtasking of the mind or the emotions. Severe illness, fear, worry, anxiety, or hard mental work, may cause either of these results.* Various hair dyes and similar preparations are sometimes used to restore the growth or the color of the hair; but most of them contain poisonous substances, which are liable to enter the skin by absorption, and often produce serious results.

CLOTHING.

Why the Body should be clothed. — The body needs to be protected by clothing as much as the flesh and other organs need the protection of the skin. Savages, and people who live in warm countries, wear much less clothing than those who are refined, or who live in colder

* The hair may become white or gray in the course of a few hours. In most cases this has occurred in connection with intense mental agitation. The cases of Marie Antoinette and Sir Thomas More are widely known, and more carefully authenticated cases leave no doubt that such a change may occur. It is supposed to be caused by the entrance of air into the pith of the shaft; but how its entrance there is effected is difficult to imagine.

climates. Those who go without shoes come to have the skin on their feet so tough and thick that they can walk and run without pain, even over stony surfaces; and in savages somewhat the same effect is produced by the general exposure of the body. But in civilized countries the general use of clothing has made it necessary, not only as a protection from hurt and from extremes of heat and cold, but also as a means of adornment.

How the Body should be clothed. — The clothes we wear should be carefully adapted to the needs of the body and the demands of good taste. Parts specially exposed to injury, as the feet, need the strong protection of shoes; and these need to be heavy or light according to the service which they are intended to perform. The head needs such a covering as will keep it warm in cold weather, and cool in warm weather. It should also be such as will shield the eyes from excessive light. Flannels, other woolen goods, and furs, are best adapted to retain the heat of the body. Hence they should be used in cold weather. Cotton, linen, and silk readily conduct the heat from the body, and should therefore be worn when the weather is warm. Light colors are warmer in winter and cooler in summer.

Special care should be taken to keep all parts of the body absolutely dry at all times. Whenever it is necessary to walk in the wet, the feet should be protected by overshoes, and waterproof garments and an umbrella should always be used when they are needed. But, as overshoes and waterproofs not only keep the moisture out, but also prevent the perspiration from escaping, they should never be worn in dry weather, or kept on in doors. If, from unavoidable causes — as from excessive perspiration, being caught in a shower, or stepping into the water — any portion of the clothing becomes wet, it should

be immediately removed, and dry clothing should be put on.*

The clothing should never be worn so tight as to interfere with the entire freedom of the body. Very tight

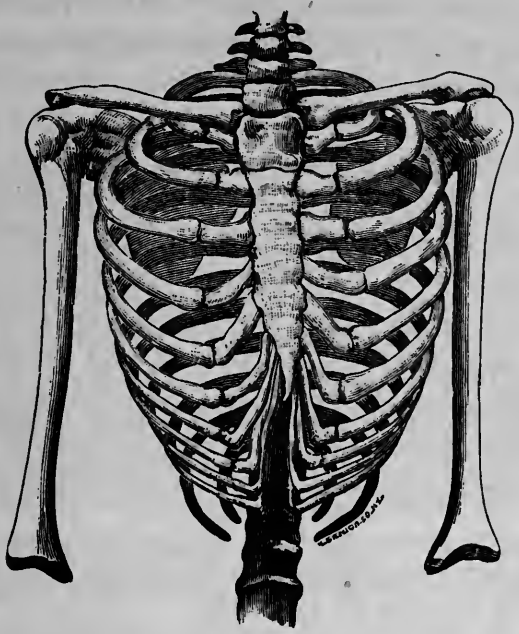

FIG. 31. — Deformity of the ribs, caused by wearing clothing tight at the waist. For the natural position of the ribs see Fig. 25.

shoes and tight clothing at the waist, are the two most serious evils in modern dress.†

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* The neglect of these simple precautions has caused almost numberless *colds*, *catarrhs*, and more serious diseases. *Pneumonia* and *consumption* often follow such apparently slight carelessness as wearing insufficient wraps or wetting the feet.

† The apparent tendency of the times to more freedom in these articles of dress is an evidence of the benefits of physiological study; but a great amount of instruction is still needed. Shoes with high heels, by throwing the feet out of their natural position, frequently cause *serious injury* to various parts of the body, especially the eyes. Care should be taken to avoid any article of clothing which contains poisonous coloring matter. No clothing should be worn which leaves any indication of color upon the skin.

"Never allow yourself to feel cold if you wish to avoid being ill," was the advice of a wise physician. "If you feel chilly," said he, "put on more clothing, go into a warm room, or exercise until you feel warm. In some way get warm and keep warm." Much sickness may be avoided, and many valuable lives lengthened by observing this rule.*

HYGIENE OF THE SKIN.

Since the skin is full of *pores*, some of which give off waste, and some of which absorb matter from the outside, it is very important that these pores be kept open. As the skin covers the entire body, it is also important that every part of it should be kept soft and elastic, so as not to press uncomfortably upon the delicate organs beneath.

From these facts, and from the foregoing discussion, the following hygienic laws in regard to the skin become obvious:

I. The skin should be kept clean, so as to allow waste matter to be readily carried off.

II. We should exercise freely, so that the blood may circulate properly in the skin.

III. The skin should be frequently rubbed, to help the circulation of the blood, to excite the secretion of oil which softens the skin, and to keep the scarfskin from clogging the pores.

IV. Drafts of air and sudden chills should be avoided, as they drive the blood away from the surface, cause the skin to shrink, and close up the pores.

V. In handling poisonous matter of any kind, we

* Very many colds are caused by insufficient clothing. Whenever a sense of chilliness is felt in any part of the body, it is a signal from the nerves that more protection is needed; and this warning should be heeded, no matter in what season of the year, or at what time of day, it is given.

should be careful not to let it come in contact with the broken skin, lest it be absorbed.

VI. When, from any cause, we have but little vitality, we should not take a cold bath, because there is danger that reaction may not follow.

VII. That the hair may be vigorous, it should be kept clean, and brushed often, and the dry, harsh ends should be clipped off.

VIII. The scalp should be kept clean and be sometimes gently rubbed; then it will supply the hair with all needed nourishment, and will render the use of oil and "hair invigorators" unnecessary.

IX. If you would have a clear and healthy complexion, avoid the use of all kinds of alcoholic liquors.

X. Clothing should be changed with the temperature, to protect the skin from extremes of heat and cold.

XI. Clothing worn next to the skin is soon filled with waste matter, and should be frequently changed. The same clothing should not be worn day and night.

XII. The clothing should not be worn so tight as to keep the blood away from the surface of the skin, to interfere with breathing, or to prevent the free use of the muscles.

XIII. We should never allow ourselves to feel cold. If chilly, we should at once put on more clothing, go where it is warmer, or in some way get warm and keep warm.

SOMETHING TO FIND OUT.

1. Why are the nails upon the fingers and toes harder than other parts of the skin?

2. Why is the skin of the head furnished with a thick covering of hair?

3. What becomes of the waste matter thrown out by the pores of the skin?

4. How does vigorous exercise affect the amount of waste matter thrown off?

5. What harm comes from breathing air filled with this waste matter?

6. Why should the plaster walls and ceiling of a schoolroom be frequently whitewashed with lime?

7. Why is outdoor air better to breathe than the air of inhabited rooms?

8. How may the air of inhabited rooms be kept pure?

9. What causes the peculiar effect upon the skin which is called "goose flesh"?

10. When "goose flesh" appears, or the skin becomes suddenly pallid, what should be done?

11. How does the skin appear when the blood circulates freely through it?

12. What internal organs are relieved by the free circulation of the blood in the skin?

13. To what danger are nurses exposed by being with persons who are ill?

14. What particular danger should be guarded against in surgical operations?

15. Why, in taking a bath, is slightly warm water usually safer than very cold water?

16. In what way is an excessive use of soap in a bath injurious?

17. Why is a boy, when dirty, more liable to do a mean thing, than when he is clean?

18. Are all children to blame for an untidy appearance? Should they be reproached for it?

19. Why is the practice of wearing fur caps and close-fitting hoods injurious?

20. What kind of head coverings are the best for summer?

21. What peculiar head coverings are worn by people in very hot climates?

22. Why do we need more clothing when asleep at night than when we are about in the daytime?

23. Why should we take off rubber overcoats and overshoes immediately on coming into the house?

24. When we are exposed to great cold or heat, why is woolen clothing better than cotton?

25. When our feet become wet and cold, how may we avoid chilblains?

26. Why do people in the Arctic regions dress in the skins of fur-bearing animals?

27. In case of a slight burn or a scald, what part of the skin rises into a blister?

28. When the skin is burned, why should the air be at once excluded?

29. Of what use are linseed oil, plasters of flour mixed with water, and plasters of clay, in case of a burn?

30. What indicates that the true skin has been cut or burned?

31. How do the blood vessels of the skin often become permanently enlarged?

32. How does the blood flow through these enlarged vessels?

33. What condition of the skin often results?

34. When the skin fails to perform its work, upon what other organ does the work fall?

35. What is the work of the kidneys?

36. How are they affected by alcohol?

37. What may the continued use of small quantities of alcoholic drinks do to the kidneys?

TOPICAL ANALYSIS OF CHAPTER X.

How the Body is covered.

Uses of Covering.
1. Protects internal organs.
2. Performs important functions.

Structure of the Skin.
1. Structure varies: callus — corns — nails — hair.
2. Layers of the skin:
   1. The scarfskin: dandruff — coloring matter — complexion.
   2. The true skin: elevations — openings.
3. How the skin is kept soft: oil tubes — oil glands.

Functions of the Skin.
1. Casting out waste: the sweat glands — the kidneys.
2. Regulating heat: sensible and insensible perspiration.
3. How the skin absorbs.

Care of the Skin.
1. Cleanliness of the skin: necessity — bathing.
2. Temperature of the skin: clothing — artificial heat.

Alcohol and the Skin.
1. Alcohol causes blood vessels of the skin to enlarge.
2. Makes the skin dry.
3. Gives the kidneys too much work.
4. Small amounts injurious.

The Hair.
1. Uses of the hair:
   1. Protects from extreme heat and cold.
   2. Breaks the force of blows.
   3. Shields organs of sense from injury.
2. Structure of hair: the pith — the shaft — the root.
3. Health of the hair:
   1. Dependent on general health of the body.
   2. Necessity of cleanliness.
   3. Grayness and loss of hair.
   4. Effect of motion.

Clothing.
1. Clothing protects and adorns.
2. It should be sufficient in quantity.
3. It should be suited to circumstances.
4. It should be clean and dry.
5. It should be easy.
6. It should always keep the body comfortably warm.

Hygiene of the Skin.

Something to find out.

CHAPTER XI.

How Bodily Motion is directed.

Bodily Organs must act in Harmony. — If each internal organ of the body should act without regard to the other organs, life could not exist; for life can be sustained only by the various organs acting together in *harmony*. If the external parts, as the arms and the legs, could not be made to act together, the body as a whole could do no useful work, and the mind could not carry out its plans. In order, therefore, that growth or repair may go on in the body, and that the mind may make good use of the body, all bodily movements must be under orderly *control*. This control is effected by means of the *nerves*.

THE NERVOUS SYSTEM.

How the Nerves are distributed. — Throughout the body there is a *nervous system*, which in some respects is very much like the system of blood vessels; the parts that correspond to the heart being *nervous centers*, and those that correspond to the veins and the arteries being *nervous cords*. Starting from the nervous centers, these cords divide and subdivide until they branch into great numbers of exceedingly minute, hair-like threads, extending to every part of the body. In the skin they form a network so close that the finest needle can not pierce the skin without coming in contact with some of them.

The most important nervous centers have special names but the cords are generally spoken of as "nerves." *

Nerve Matter. — There are two kinds of nerve matter, *white* and *gray*. Under the microscope the white matter appears as minute *threads* and the gray as tiny *cells*. The white matter is much greater in quantity than the gray, but the two are found together in all the nerves of the body.

The Brain. — The principal nerve center, corresponding to the heart in the circulation, is the *brain*. It occu-

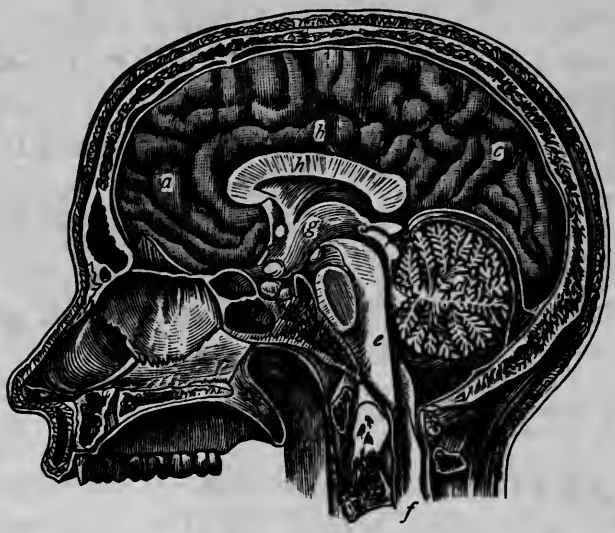

FIG. 32. — The brain inclosed in its membranes, and the skull: *a*, *b*, *c*, folds, or convolutions, of the cerebrum; *d*, the cerebellum; *e*, medulla oblongata; *f*, upper end of the spinal cord; *g*, *h*, central parts.

pies the main cavity of the head, and is carefully protected from injury by the skull. The front and upper

* The nervous centers are of various sizes, from the brain, which ordinarily weighs about three pounds, down to the little knots, or *ganglions*, found in the course of the nerves in various parts of the body. These knots are called "ganglions," or *ganglia*, as they were called by the ancient Greeks, in whose language "ganglion"

part of the brain, about seven eighths of the whole, is called the *cerebrum;* the back and lower portion, the *cerebellum*, or "little brain."

The interior mass of the brain is composed of white matter, but the entire surface has a thin covering of gray. The surface of the cerebrum is made up of irregular rounded *ridges*, or *folds*, giving to it a large amount of surface.* In the cerebellum the ridges are parallel and less rounded. A deep indentation extending from front to back divides the brain into parts, so that in reality the brain is *double*, corresponding to the pairs of the external portions of the body. From the nervous mass within the skull *twelve pairs* of nerves extend to different parts of the head and face.

FIG. 33. — Upper surface of the cerebrum, showing the convolutions of the brain and its double structure.

The Spinal Cord. — From the brain a mass of nerves, called the *spinal cord*, extends downward through the

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meant the same that "knot" does in ours. The word "nerve" comes from the Greek word *neuron*, which means "cord." The word came to be used because the Greek physicians, though they were the most noted of ancient times, thought that the nerves were the same as the tendons, which look much like the nerves and which we generally speak of as "cords."

*The ridges of no two brains are exactly alike. In infancy they are plainly visible, but they deepen and become more marked with age. In the civilized races the brain folds are deeper and much more numerous than in savages. They are also more extensive in a studious and

spinal column to the lower extremity of the trunk. An enlarged part of this cord, which lies next to the cerebellum and within the skull, is called the *medulla oblongata.*

FIG. 34. — The cerebrum, the cerebellum, the spinal cord, and the general distribution of the nerves.

Thirty-one pairs of nerves issue from the spinal cord and extend to the different parts of the trunk and the limbs. These are called *spinal nerves.* Each of these nerves issues from the spinal cord in two parts, or *roots*, one coming out of a groove on the back portion of the spinal cord, and the other from a similar groove in front. Each back root brings feeling to the spinal cord, and each front root carries orders to muscles. These roots soon unite and form a single nerve, and near their point of

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thoughtful person than in one who does little thinking. The greater the number and depth of the folds the greater is the amount of brain surface, and the greater the amount of gray matter which covers the surface. It is therefore supposed that the gray matter increases with study and thought, and with any active business which depends upon thinking and demands intelligent control. It is estimated that in some of the most perfect human brains there are nearly eight hundred square inches of surface.

meeting is a little *knot* of nervous matter.* These knots form a row on each side of the spinal cord; but, as each lies in the course of a single nerve, they have no direct communication with each other.

Sympathetic System. — Besides the nerves which branch from the brain and the spinal cord, there is another set or system of nerves by which such organs as the heart, the stomach, and the liver are connected with one another. The knots which serve as centers for these nerves are linked together so as to form two rows, which extend, one on each side of the spinal column, through the cavities of the trunk, and along the neck into the head. This is called the *sympathetic system*, because through it the organs thus connected can act together, or in "sympathy" with one another. Small threads of nervous matter connect this system with the nerves that issue from the spinal cord and the brain.

NERVOUS ACTION.

What the Nervous System has to do. — Without nervous action the body and its organs would be as quiet and as useless as a factory and its machinery without a superintendent and workmen; it would, in fact, be dead. It is, therefore, plainly the *work of the nervous system* to carry on the processes of life in our bodies, and to see that we get such knowledge, and make such use of it, that our lives shall be of the greatest possible value to ourselves and to every one else. To enable the nervous system to accomplish as much as possible of this great

* In fact, every collection of gray matter, which is separated from other masses of gray matter by intervening white matter, is called a *ganglion*, and so even the different parts of the brain are included under this name. (Tracy.)

undertaking, each part of it has some special work to perform.

How the Nerves carry Messages.—It is the special business of the nervous cords to *carry messages* to and from the nervous centers. Of the threads which make up these cords, some report to the nervous centers, as fully as possible, all that is going on in the part of the body where they are placed, and everything of importance that they can find out by any means in their power. Because they are able to do this work only by the sense of feeling, or through some one of the special senses, these are called *nerves of sense* or *of feeling*. It is the business of another set of nervous threads to carry orders from the nervous centers to the muscles, whenever the nervous centers decide that the muscles ought to make certain motions. As the muscles move in obedience to the messages carried by them, these nerves are called *nerves of motion*. Most nervous cords contain both these kinds of threads, but some are made up of one kind only.*

We have an example of both these kinds of messages when the naked toe comes in contact with a live coal. A message is immediately sent along the nerve of feeling to the brain, telling the mind that the toe is burning. The mind at once telegraphs back, along the nerve of motion to the proper muscle, an order to draw the toe

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* The nervous threads that carry messages to the nervous centers are commonly called *sensory nerves*, and those that carry orders to the muscles *motor nerves*. In just what way or by exactly what means messages are carried by the nerves we do not know. Dr. Mapother says: "*Nerve force* is, at least, a cousin of *electricity*, for the electric eel and ray give their shock by the masses connected with the brain: electric sparks may issue from the body, and, when dead, its muscles act by that great power as if the will directed them. The forces are not the same, for electricity travels millions of times faster than thought or will. At any rate, the nerves are like telegraph wires."

away from its dangerous position. The muscle obeys, and the toe is saved.

Work of the Nervous Centers in General. — It is the business of the nervous centers (1) to *receive the reports* brought to them by the nerves of sense; (2) to *decide* what use shall be made of the information thus obtained; and (3) to *direct the actions* of the muscles when their action seems necessary or desirable.

What Some Special Nervous Centers have to do. — The kind of work done seems to be about the same in all the nervous centers, but the purpose of the work, or the part of the body for which it is done, differs in different centers.

1. The cerebrum is the *seat of the mind*, or the part of the brain that acts when a person is studying, planning, or doing other mental work. It is the part of the brain that is used when we are deciding between right and wrong actions.*

2. The cerebellum is the center which *makes the limbs move together*, so as to help one another in performing such acts as walking, skating, and swimming.

3. Sometimes the spinal cord receives messages from the nerves of sense and gives orders to the muscles without consulting the brain at all, and some of the smaller centers can do the same thing. Because the spinal cord and these centers can do this, they have charge of those *movements of the body which can be performed with*

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* When a pupil is intent on the study of a subject, and takes all possible pains to understand it, the mind controls every step, the nerve action is *direct*, and both the brain and the mind grow. When he is engaged in learning and reciting merely the words of a text-book, with little or no attention to the thought, the mind is only half conscious, the nerve action is almost mechanical, and neither the brain nor the mind is much benefited.

*little or no distinct thought.** The process of breathing is chiefly under the control of the medulla oblongata.†

4. The small centers of the sympathetic system have almost the entire *charge of the heart, the stomach, and the other vital organs*, in which "they arrange the due amount of blood to flow, and the heat or growth which results." Besides regulating the action of these organs, the nerves of this system make any disturbance in one of them felt in all the others.

The mind has no direct control over the action of the heart, the liver, or any other of the vital organs, so that the processes of life go on without the action of the will. If the brain had to pay close attention to these organs and processes, it could probably attend to but little else; and, besides, life would cease if ever the mind should forget or fall asleep.

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* If it [the spinal cord] is cut, therefore, say in the loins, the man feels no pain if his legs be hurt, nor can his will move them. The feet of such a poor palsied fellow were tickled, and, being asked if he felt it, he said, "No, but you see my legs do," for they were kicking about. Thus it was seen that the cord can receive feelings and call forth motions of itself. The brain of a sleeping child is at rest, but if you put your finger on his palm it is grasped at once, the feeling being brought to the cord, and the order for motion from it by *reflex action*, as we say. Feelings are also sent downward; thus, if you hit the nerve at the elbow — the funny bone — the little and ring fingers will tingle. (Mapother.)

† Breathing is partly under the control of the will. We can suspend our breath for a brief time, but soon the motion of breathing will be resumed in spite of the will. A case is on record of a man who could by an effort of his will control the beating of the heart. He tried the experiment of stopping his heart "once too often," and it never began again.

Coughing is caused by this kind of nervous action operating upon the muscles in the lungs. When a bit of food gets into the windpipe, the cough throws it out. Diseases of the lungs produce the same feelings as the presence of foreign substances, and hence lung diseases

Habit and Training. — In whatever is done on purpose, the mind, through the brain, directs the first steps. But when actions are repeated a sufficient number of times, the muscles become accustomed to the movement, and the acts are performed with ease. When this is the case, the direction of such acts is given over to the *lower nervous centers*,* and the actions are performed almost without thinking.

The name given to this unconscious repetition of an action is *habit.*† The precision and rapidity of action which come from habit constitute *skill;* and the method by which skill is obtained is training.‡ The training which converts acts into habits relieves the mind and the brain, and leaves them free to study new things and to perform new acts.

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are accompanied by coughing. *Sneezing* is a similar action produced by foreign substances or disease in the nose. The *hiccough* is a sudden action of the diaphragm, caused by exhaustion, as from excessive laughter, or from the effect of alcohol.

* The lower centers are those residing in the backbone, and known as the spinal column. The higher centers, lodged within the skull, are called the brain. (Sully's "Hand-Book of Psychology.")

† Habits once formed are difficult to overcome. Habits formed in youth are the most lasting. The old man is slovenly because as a boy he was untidy. The fine scholar can not in his oration entirely get rid of the inelegant expressions of his childhood. The cruel boy, who is unkind to his playmates or careless about inflicting pain upon animals, becomes the brutal man.

Good habits are equally durable. The kindly acts of the boy or the girl ripen into kindness in the man or the woman. When effort to do things well becomes a fixed habit, it makes life rich in welldoing.

‡ A young lady beginning to play the piano is obliged to fix her whole attention upon the position of her hands and upon the keys she is to strike. When training has given her skill, she strikes the keys correctly without thinking, and she is able to give her whole attention to the music. In like manner, skill enables the workman to do his best work with the least conscious attention.

USE AND ABUSE OF THE NERVES.

Exercise.— Like the other parts of the body, the nerves can neither become strong nor keep so unless they have proper exercise. When we observe objects, find out their qualities, and compare them with other objects, we exercise the nerves of sense or feeling. When our hands do something under the direction of the mind, we exercise the nerves of motion. In both these cases, and *in all thinking, the brain is exercised.*

As all bodily action depends upon the nerves, the whole body suffers if nerve exercise is neglected. The vital organs are then feeble in their action, the blood moves slowly in the veins and the arteries, the muscles become flabby and weak; and the starved mind, working through the starved brain, gradually loses its vigor, until it becomes little better than idiotic. To prevent this result, the *mind requires daily activity* in careful study, or through some useful work.*

Rest of the Nerves. — The nerves also need rest. Like the muscles, they become exhausted with exercise. Nightly sleep furnishes the necessary rest for proper daily exercise. If, during the day, the nerves are unduly exercised or strained, they become enfeebled, and sleep does not restore their vigor. If the strain is continued, sleep is broken, the weariness increases, and the nervous system breaks down, leaving the person a helpless bur-

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* The nerves are greatly affected by emotion. By a joyous and happy mood nervous action is increased, the vital organs are stimulated to do their work well, and a glow of health pervades the whole body. Grief diminishes nervous action. Sudden bad news sometimes so paralyzes the nerves that the heart ceases for a time to beat, and faintness, or even death, is the result. Ill temper, envy, sulkiness, and all kinds of selfishness and meanness, diminish nerve force, and tend to derange the action of the vital organs.

den to others. Excessive study, or excessive work of any kind which requires brain labor, often results in *congestion* or *softening of the brain*, or in *paralysis*.

How Alcohol affects the Nerves. — Alcohol and other narcotics deaden the nerves, and so diminish their action. This effect first shows itself in the nerves which control the passage of the blood through the small arteries. The half-torpid nerves can not keep the muscular walls of the blood vessels from expanding too much, and the minute vessels are gorged with the unusual amount of blood within them. This gives to the skin a peculiar redness, which quickly shows itself in the delicate skin of the face.

If the alcohol is continued until the habit of drinking is formed, the derangement of the nerves becomes more marked. The heart is weakened and grows feeble in its action; the nerves lose control of the muscles and the limbs stagger; and all the organs are more or less out of order, because the nerves which ought to produce harmony of action are paralyzed.

Effect on the Mind. — You have learned that water is an important part of the human body. A healthy brain is more largely composed of water than is any of the other organs. Anything that will deprive the brain of this water, that should at all times saturate its tissues, will injure it and make it unable to do good work. Alcohol has a strong affinity, or liking, for water. As it is carried by the blood to all parts of the body, it will not only unite itself to the water it finds, but will subtract water from the tissues, leaving them shrunken and unfit to do their proper work.

This is one of the ways in which alcohol injures the brain. Such injuries of the brain cause injurious changes in the character and ability of the drinker. The brain

of the habitual user of alcohol is often found after death to be unnaturally firm and hard as if it had lain for some time in alcohol. Alcohol has been found in such quantities in the brain of a drinker after death that it might be detected by its odor or by other tests.

When alcohol is taken, though only in small quantities, the brain of the drinker is gorged with blood. The mind may then appear unusually active, but it can not do as good thinking as it could without the alcohol. The old notion that a little wine, brandy, or any alcoholic liquor will help a person to do better brain work is a great mistake.* Alcohol is an enemy to the brain and to good brain work.

Alcohol paralyzes the cerebrum much more quickly than the cerebellum. In consequence, its effect is to dethrone for a time both the intelligence and the moral nature, while the appetites and passions have sway in proportion to the amount of alcohol drunk. The drinker loses his reason and judgment, and is left to do and say many things that he would not if his mind were clear. Kindness is thus turned to cruelty, honesty to dishonesty, and truth to falsehood. The natural affections of the drinker seem blunted. He does not hesitate to cause the keenest pain to father or mother. He often deserts his wife and children, leaving them to starve or freeze while he spends his last cent for drink. In this way a man is

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* With wine inflated, man is all upblown,
And feels a power which he believes his own;
With fancy soaring to the skies, he thinks
His all the virtues all the while he drinks;
But when the gas from the balloon is gone,
When sober thoughts and serious cares come on,
Where then the worth that in himself he found?
Vanish'd — and he sank grov'ling on the ground. — *Crabbe.*

often converted into a brute, dangerous to his family, to his neighbors, and to himself. Continued drunkenness often ends in *delirium* and death.

How Tobacco affects the Nerves. — The general use of tobacco diminishes nervous action. It is a substance which enters into the system without furnishing any needed element. It is in the body, but not of it. In sufficient quantities it has a particularly paralyzing effect upon the nerves which control the muscles of the heart and is capable of weakening the heart's action to such a degree as to cause *spasms* and *insensibility*.

Tobacco leads to *uncleanly habits* and to carelessness of the comforts and rights of others. Smokers and chewers befoul with their tobacco the air which others must breathe, and eject upon steps, floors, and sidewalks its offensive juice.

Heredity. — Dr. B. W. Richardson says of the evil effects that result from the use of alcoholic liquors: "In whatever way the physician turns his attention to determine the persistent effects of alcohol, he sees nothing but disease and death, — mental disease and mental death, physical disease and physical death." But great as these evils are they do not stop with the health, character, and life of the drinker. We say a child looks like his father. That resemblance may not be confined to the face alone; the brain, nerves, and other organs, may be as much like the father's as the face. Alcohol will shrivel the nerves and brain of the drinking parent, weaken his will, sear and blunt the conscience, and give him a craving appetite for more alcohol. It will make him coarse, cruel, and brutal. As the face of the child may look like the face of the parent, so the child may inherit any of these conditions that alcohol has produced in the parent.

An *appetite for alcoholic liquors* with a weak will with

which to control it, *insanity*, *idiocy*, *epilepsy*, and other diseases of the brain and nervous system are frequent results inherited by children from the drinking habits of parents. The late Dr. Willard Parker said of such cases: "When alcoholism does not produce insanity, idiocy, or epilepsy, it weakens the conscience, impairs the will, and makes the individual the creature of impulse and not of reason."

Children inherit from their parents nerves weakened by the use of tobacco as well as of alcohol, and the lives of thousands of innocent persons are thus made miserable. Usually the first drink and the first smoke are found to be very disagreeable, but sometimes an inherited appetite shows itself, and the sweet breath of the child becomes foul with the whisky and tobacco which can not be kept out of his way. Beginning with this unnatural appetite, habits are speedily formed which make his life a burden to himself and to others.

HYGIENE OF THE NERVES.

As the nerves control all the movements of the body, both conscious and unconscious, and thus affect its nourishment, we need to take the greatest care to keep them healthy, and especially to avoid all courses likely to injure them.

I. We must observe all the laws of digestion, so that the brain and the nerves may be supplied with pure blood.

II. We must avoid breathing foul air, or the nerves will be paralyzed by the impurities of the blood.

III. To keep it in health, the brain should every day be brought into vigorous action by some form of study or thinking.

IV. Active daily exercise, by either work or play, is

necessary to secure the healthful action of the nerves distributed through the body.

V. We need a great variety of objects to observe, to handle, and to study, in order that the nerves of sense may receive sufficient exercise.

VI. We need a great variety of work, having for its end some useful purpose, that the nerves of motion and the brain may be excited to healthful action.

VII. When we are tired we need rest, because as much nervous force as we can spare has been used up. Sleep, the natural rest from daily toil, should be regular, and should continue until the vigor of the nerves is restored.

VIII. The hardest study and the closest thinking should be done when the nerves are most vigorous, and that is usually during the first half of the day.

IX. We should never try to think or study when we are sleepy. In the first place, we then need sleep more than knowledge; and, in the second place, we gain very little knowledge when the mind is weary.

X. We should avoid continued and excessive mental work, because it may become so exhausting as to break down the whole nervous system.

XI. When the nerves have become so exhausted that we can not sleep, we must give up all labor and thinking until the nerves have recovered their lost strength.

XII. Cramming for an examination is much more exhausting than a much longer period of regular study, and should be avoided.

XIII. We should try to do those things which will form good habits, so that we may easily and certainly perform good deeds throughout life.

XIV. We should take special pains to avoid doing anything which tends to form bad habits, because it

will be always difficult, and sometimes impossible, to correct such habits when they have once been formed.

SOMETHING TO FIND OUT.

1. In study, what should always be our object?

2. In the study of science, what evils come from trying to learn merely the exact words of a text-book?

3. What is the effect of adding careful experiment to the study of a subject?

4. In case we do not understand a subject that we have studied, what is to be done?

5. Why is it injurious to attempt to hold the breath for any considerable time?

6. When we have eaten too much, what symptoms besides sickness at the stomach, may we expect?

7. After we have learned to walk, what part of the nervous system controls the act of walking?

8. What trouble would there be if the mind had to give constant attention to walking and similar acts?

9. Why is it easier to perform an act the second time than at first?

10. What is the result of doing one act repeatedly?

11. When we perform acts without much thinking, what have we acquired?

12. What kinds of acts lead to the formation of good habits? of evil habits?

13. What does a person need in order to become a good baseball player?

14. What term is applied to persons who do not like to exercise either body or mind?

15. What good do we get from play that we do not get from work?

16. What good results from work that does not come from play?

17. Why is night the best time for sleep?

18. What good comes from having sleep at regular hours?

19. Why should we give up study when we are sleepy?

20. What kind of games are beneficial to students while attending school?

21. What kind of games would injure rather than benefit them?

22. Explain how a game may be beneficial to a farmer when it would injure a student.

23. What class of people is most benefited by a week's fishing in summer?

24. How does alcohol cause the minute blood vessels to become gorged with blood?

25. How does work done by the brain, when it is under the influence of alcohol, differ from that done when it is in a healthy state?

26. What part of the brain is first paralyzed by alcoholic drink?

27. What part of the drinker's nature is then left without restraint?

28. What acts does the drinker commit which show how alcohol injures his moral nature?

29. In what condition is the brain of the drinker often found after death?

30. What do the children of drinking parents frequently inherit?

31. What is the effect of alcohol on the nerves?

32. In what nerves does this effect first show itself?

33. What is the result?

34. What is the condition of the brain when the blood vessels of the skin are thus gorged?

35. Will alcohol help the brain to do better work?

36. What kind of work does the brain do when thus excited?

37. What can you say of the reason and judgment after alcohol has been taken?

38. What is the result?

39. What is the condition of the nerves of the habitual user of alcohol?

40. What movements are directed and controlled through the cerebellum?

41. Of what is the healthy brain largely composed?

42. What will be the effect if anything deprives the brain of its due amount of water?

43. What liquid has a strong affinity for water?

44. What does alcohol do as it is carried by the blood to all parts of the body?

45. What proof can you cite that large quantities of alcohol go to the brain?

46. What must be the effect of this upon the tissues of the brain?

47. When the brain is injured, what is the effect upon character and ability?

48. Of what is the cerebrum the seat?

49. Which part of the brain does alcohol most quickly paralyze?

50. What follows from this?

51. When is a man like a brute?

52. How does tobacco affect the nerves?

53. How does its action upon the nerves affect the heart?

54. What effects upon the habits and manners does the use of alcohol often produce?

55. In what way can we best avoid the dangers and miseries which come from drunkenness?

TOPICAL ANALYSIS OF CHAPTER XI.

How Bodily Motion is directed.

Direction Necessary.

1. To nurture the body.
2. To execute plans.

The Nervous System.

1. Distribution of nerves.
   1. Centers: special names — various sizes — knots or ganglions.
   2. Cords: start from centers — reach every part of body.
2. Nerve matter: gray cells — white threads.
3. Nerve centers.
   1. Brain: cerebrum — cerebellum — folds — double structure — twelve pairs of nerves.
   2. Spinal cord: medulla oblongata — thirty-one pairs of spinal nerves — roots — knots.
   3. Sympathetic system: knots — connections.

Nervous Action.

1. Work of nervous system: carry on processes of life — get and use knowledge.
2. Carrying messages: nerves of feeling — nerves of motion — nerve force.
3. General work of centers: receive reports — use information — direct actions.
4. Work of special centers.
   1. Cerebrum: seat of mind and higher nature.
   2. Cerebellum: harmonious movement of limbs.
   3. Spinal cord: movements requiring little thought.
   4. Sympathetic centers: vital organs.

Use and Abuse of Nerves.

1. Exercise: thinking — daily activity.
2. Rest: sleep — joyous emotions.
3. Effects of alcohol.
   1. Deadens nerves and diminishes action.
   2. Gorges small arteries with blood.
   3. Weakens heart and leaves muscles without control.
   4. Injures brain work and debases character.
   5. Evil effects inherited by children.
4. Effects of tobacco.
   1. Diminishes nervous action.
   2. Causes filthy habits.
   3. Evil effects inherited by children.

Hygiene of the Nerves.

Something to find out.

CHAPTER XII.

How the Mind gets Ideas and expresses them.

What the Body is for. — The body and all the wonderful organs and processes by which it is kept alive are of no real use except to furnish a dwelling place for the mind, and *the means by which the mind can get knowledge and make good use of it.* All that we know of the world and the things in it we learn through the nerves of sense. When anything found out by the nerves of sense is fully known to the mind it is called an *idea.*

The Five Senses. — Though all the nerves of sense report to the mind whatever they can find out, we know that some of them can find out things which the others can not. From nerves in the muscles we get ideas of pressure and weight. Through the nerves of feeling in the skin we get from the surface of objects the ideas which are expressed by such terms as square and round, large and small, hard and soft, rough and smooth, hot and cold. But these ideas are not enough. The mind needs to know about flavors and odors; it must get from sound its meaning and its music; and from light it must learn the beauty of form and color. For these purposes some of the nerves of feeling take the form of *special nerves of sense*, as those of taste, smell, hearing, and sight. As there are at least five different kinds of knowledge which the nerves of sense bring to the mind, or five different

ways in which the nerves of sense get information about objects, we say that there are *five senses*.

THE SENSE OF TOUCH.

The sense of *touch* is shared by the whole surface of the body, and so can hardly be called a "special sense," except when it is used for the purpose of getting knowledge of objects. The skin is the special organ of this sense. The nerves of touch end in the little elevations or points of the skin, which we can see arranged in curved rows at the tips of the fingers where the sense of touch is most perfect. This is a very important sense, and gives us a great deal of information that we could get in no other way. It also makes it easier for us to do many things that we have to do, and it often gives us warning of things that might do us harm. We should, therefore, try to make it, and keep it, as perfect as possible. By means of this sense the blind get, from objects which they can reach, much of the knowledge which ordinary persons get through the sense of sight. By it they learn, also, to do many things for which most persons need to see.

THE SENSE OF TASTE.

The Taste as a Sentinel. — Special care must be taken that improper food be not admitted into the stomach. The mind must keep close watch over all things eaten, and must reject such as will be likely to injure any part of the body. One means by which the mind tells whether food is good or bad is the sense of taste.

Flavors. — When food is taken into the mouth, it gives an effect which we call *flavor*.* The nerves which flavors

* The primary and strongest flavors are *sweetness*, *sourness*, *saltness*, and *bitterness*. Besides these, there are the flavors peculiar to

affect give us the sense of *taste*. They are distributed over the *tongue* and the back part of the mouth. Many substances when taken into the mouth may be felt but not tasted. Touch takes notice of certain qualities of all substances; taste notices flavors only, but not until the surface of the substance yielding the flavor is dissolved by saliva. We can get no idea of flavor except through the nerves of taste.

Before flavors can be perceived, the substance must come in direct contact with the nerve. When a strong flavor has been tasted, the effect will remain for some time, and will prevent us from noticing other flavors. Except in disease, the flavor of nearly all healthful foods is pleasant, and the necessary act of daily eating is thus rendered agreeable.*

THE SENSE OF SMELL.

Odors. — Another of the means employed to test foods is the sense of *smell*. Certain substances give off something that we call *odor*. The nerves which odors affect, giving us the sense of smell, are distributed through the cavities of the nostrils.† Substances smelled do not come

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different fruits, such as peaches, grapes, etc., and the flavors peculiar to the different varieties of the same fruit, as that of Catawba and of Delaware grapes. It is thought by some that all possible flavors are made up of different combinations of the four primary ones; but this point is not settled.

* The sense of taste is not a perfect guide in the choice of foods. One condition of good digestion is that food shall be pleasant to the taste. But such food is not always wholesome, and the mind must have other means of deciding what shall be eaten.

The act of eating is agreeable; but, if we give ourselves up to the pleasures of the appetite, swine have an advantage over us, as they appear to enjoy eating even better than we do.

† The nerves of smell notices nothing but odors. Unpleasant odors denote the presence of something hurtful. Food that is tainted, or that

in contact with the nerves of smell, but when brought near the nose make an impression through the odors which they give off. Agreeable odors give us a sense of pleasure, and also stimulate the whole nervous system.

THE SENSE OF HEARING.

Sound. — Whenever an object of any kind moves, a portion of the air is disturbed and set in motion. Whenever an object has a continued motion to and fro, a similar wave-like motion, or *vibration*, is set up in the air. These vibrations strike upon the ear, and produce an effect which is called *sound*.* The nerves by which sound is perceived are the *auditory* nerves, and the sense that has sound for its object is the sense of *hearing*.

It is necessary that the mind should know what movements are going on around it, so that it may avoid danger, and take advantage of circumstances to carry out its purposes. It should be able to distinguish different sounds for the pleasure that music affords. The mind must also be able to distinguish and produce the sounds used in speech for the purpose of understanding and

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which gives off an unpleasant odor, is generally unfit for the human stomach. Air that smells vile is unfit to breathe. A keen sense of smell is very desirable, and it will be well to always "follow the nose" when it leads away from bad odors.

* The least number of vibrations that produce a sound which the ear can perceive is sixteen per second. As the vibrations increase in rapidity, the sound becomes higher in pitch. The highest sound that the ear perceives is made by about thirty-two thousand vibrations per second. Vibrations below sixteen and above thirty-two thousand per second are silent to the human ear.

The sense of hearing may be cultivated so that the ear will detect sounds which are not audible to other ears, and will observe differences which were before unnoticed. This cultivation makes life richer by the new enjoyments which it affords.

of expressing thought. These ends it accomplishes by means of the ear, or by its aid.

The Ear. — The ear, which is the organ of hearing, has three parts: (1) the outside or *external ear*, which we see; (2) the *middle ear*, which is a small passage through the bones, and is called the *tympanum* or *drum;* and (3) the *internal ear*, which consists of several winding passages in the bony structure of the skull. The three parts of the ear are separated by thin membranes which stretch across each end of the middle ear like the heads of a drum. A little tube leads from the middle ear into the throat.*

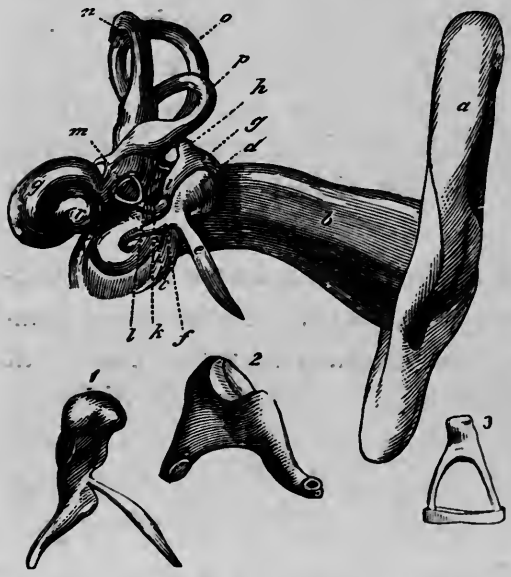

FIG. 35. — The parts of the ear: *a*, external ear; *b*, passage; *c*, membrane of the tympanum; *d* — *m*, bones and their connections; *n* — *r*, interior canals and openings; 1, 2, 3, small bones of the ear, highly magnified.

The vibrations of the air striking the outer membrane of the drum, cause it to vibrate, and the motion is reported to the brain through the nerve of hearing, which is spread over the passages of the internal ear. Thus the effect of sound is produced upon the mind. The quality and intensity of the vibrations

* Through this tube, air is admitted to the inside of the "eardrum" for the same purpose as through the hole in the side of a common drum. When we have a cold and the throat is swollen, the mouth of this tube may be closed, and we may become quite deaf for a time. The remedy is, not to doctor the ears, but to cure the throat.

are in some measure regulated by a chain of minute bones within the middle ear, and by the limpid fluid which fills all the passages of the internal ear.

Care of the Ear. — The ear needs but little care except to be kept clean; otherwise it should be let alone. The wax which lines the outer passage is bitter, and prevents insects from crawling in.* It should not be removed. In summer, boys, while in swimming, often get water into their ears. It frequently remains for a considerable time, and is very disagreeable. This difficulty may be prevented by stuffing a little cotton into the ears before going into the water.

"Boxing the ears," or striking them with the palm of the hand, may seriously injure the hearing. The outer head of the eardrum may even be split or broken in this way; just as children, to make a loud noise, sometimes force the air through a leaf or a piece of thin paper by tucking it between the thumb and forefinger of one hand and then striking it with the palm of the other hand. Similar injury may be caused by making a deafening or "ear-splitting" noise in a person's ear, or by exposing one's own ears to such a noise.†

THE SENSE OF SEEING.

Light. — It is now generally believed that light, as well as sound, is produced by vibrations. But while sound comes from vibrations of the air, light is the result

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* In spite of all care, an insect sometimes gets into the ear, where its movements sound exceedingly loud. When this happens, oil may be used to destroy the life of the intruder, and then the ear may be cleansed by means of a soft cloth.

† Blows upon the ear have rendered persons deaf for life, and in some cases young children have died from the effects of sudden and deafening noises.

of vibrations of a fluid much thinner than air, and which fills all the space between the earth, the sun, and the stars. These vibrations have no effect upon any of the nerves of the body except the *optic nerve*, as the nerve of the eye is called. Here it gives the effect which is called *light.*

Need of Light. — The mind needs to know the forms and positions of objects. The body, in traveling in search of food, must avoid the abrupt precipice, the dangerous pit, the deep water. It must have some sure guide to the things necessary to its existence. The mind must be able to judge of distance for purposes of use and protection. It also has higher needs. For its own growth and happiness it must be able to see the beauty which color unfolds, and which is found in the shifting scenes of mountain and sea, and in the varying forms of animal and vegetable life. All these come to the mind by means of light and through the eye.*

The Eyes. — The eyeballs are spherical bodies about one inch in diameter, and are placed in bony sockets in the front part of the skull. On all sides, except the front, they are protected by strong bones and cushions of soft tissue. The *eyelids*, with rows of *eyelashes* along their edges, can close over the front of the eyes, so as to protect them from dust and insects. The *eyebrows* turn the sweat on the forehead away from the eyes. *Tears* keep the eyes moist, and winking spreads the tears over their surface.†

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* By noting the colors and shapes of plants, animals, and the clouds about us, we train our eyes, and many artists have been thus educated. Such beauties of nature give a constant joy, and every cottage should have around it flowers like sweet peas or wallflowers, which a few pence will buy. ("The Body and its Health.")

† A tube connects the *tear gland* with the nose, so that extra tears

Structure. — The eye has three coats. 1. The outside coat (*sclerotic*), which is strong and tough, serves to keep the eye in shape, and also as a place for attaching muscles. This coat has an opening in front, in which is placed a transparent membrane (*cornea*), very much as a crystal is inserted in the case of a watch. 2. The middle (*choroid*) coat of the eye is made of softer tissue, and contains the blood vessels that supply the eye. The interior part of this coat is black or very dark-colored.* 3. The inside coat (*retina*) is formed by the spreading out of the optic nerve over the back part of the eye.†

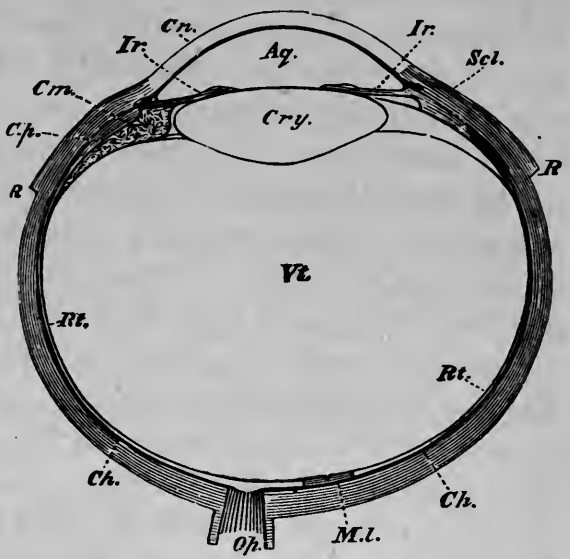

FIG. 36. — Horizontal section of the eyeball: *Scl*, sclerotic coat; *Cn*, cornea; *Ch*, choroid coat; *Ir*, iris; *Aq*, aqueous humor; *Cry*, crystalline lens; *Vt*, vitreous humor; *Rt*, retina; *Op*, optic nerve.

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usually flow through it. In case of great grief, or anger, the tears overflow, and this excess of tears is called *weeping*. Sometimes the tube leading to the nose gets obstructed, producing what is termed a "weeping eye."

* The dark interior surface of the middle coat absorbs the light which is not needed for clearness of seeing. When this black coloring matter is wanting, as in the case of albinos, vision is defective.

† Get from the butcher the eye of an ox; carefully cut away the outer coats on the back side; then darken a room, except one ray of light. In this opening place the eye, as though looking out. On the retina can then be seen a distinct image of objects outside, but they

In that part of the eye which lies behind the transparent membrane, the middle coat takes the form of a colored curtain, which is called the *iris.** If the curtain is blue, the person is said to have blue eyes; if gray, gray eyes. There is an opening in the center of this curtain through which we can see the black, or dark, color of the middle coat. This opening is called the *pupil.*

The Three Humors. — The eye contains three very clear substances called *humors.* 1. The one just back of the transparent membrane covering the front of the eyeball is called the *aqueous humor,* because it is almost entirely composed of water. 2. The one just behind the pupil is like crystal in appearance, and like a lens in shape, and so is called the *crystalline lens.* 3. The humor which lies behind the crystalline lens and fills the main central cavity of the ball is called the *vitreous humor,* because it looks so much like glass. These humors are so clear that the light can easily pass through them.†

Muscles of the Eye. — Muscles in the interior of the eye change the form and position of the crystalline lens, and enlarge and diminish the curtain, or iris, for the purpose of regulating the light. The motion of the eyeball is mainly controlled by four straight muscles which turn it up and down, and from right to left. Two other muscles,

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appear upside down. From the same eye may be obtained an idea of the brilliancy and transparency of the *vitreous humor,* the jelly-like substance filling the space back of the crystalline lens.

* The effect of light upon the iris may be seen by observing the eyes of a cat. In a strong light the pupil closes so nearly that it appears only as a faint line. In a dim light the pupil enlarges so much that the iris nearly disappears.

† The structure of the eye may be seen by dissecting the eye of an ox or a sheep; if frozen, it can be cut and examined much more easily. The lens of a fish's eye is round, and when placed upon a written or printed page magnifies the letters beneath it.

one of which goes through a pulley, roll the eye around in its socket.*

Care of the Eye. — When we read or study, the light should be thrown upon the book or object, and not into the eyes. A glare of light in the eyes makes objects appear dim. On the other hand, we should avoid trying to read or see small objects in a dim light. If the *strain* which such a practice occasions is continued, it is likely to weaken the eyes and produce temporary or permanent blindness. *Cross lights*, or lights coming into a room at different angles, are hurtful to the eye. As these lights are of different intensity, the muscles of the iris become weary of trying to properly adjust the ever-changing light.†

THE ORGANS OF SPEECH.

The mind has need to *express* thought as well as to receive it. It needs not only to learn from the experience of others, but also to give to others the result of

* When the interior muscles are too strong, the eyes are turned toward the nose, producing what are called "cross-eyes." When the exterior muscles are too strong, the eye is turned outward. These difficulties can usually be remedied by a skillful surgeon.

† The eyes may be injured by looking directly at the sun or any intense light, by keeping them steadily fixed for a long time on books or other objects, by tight-fitting collars, by overheated rooms, by lack of outdoor exercise, and in general by any practice or disease which injures the health and vigor of the body. Weak eyes may sometimes be strengthened by bathing them once or twice a day with water in which a moderate amount of salt has been dissolved. They may also be greatly protected by the use of a green shade for evening work. Great care should be taken not to overtask the eyes after they have been weakened by measles, scarlet fever, diphtheria, or any like disease. Nearsightedness and similar defects, whether inherited or caused by abuse of the eyes, generally require the use of glasses. When possible, those thus afflicted should secure and follow the advice of a competent oculist.

its own experience. The most effective means by which this interchange of ideas is brought about is the voice as heard in *speech.* Certain combinations of sounds are called words, and words express ideas.

The Voice. — The *larynx* is the prominence which lies just above the windpipe. The slit-shaped opening from the mouth into the larynx is called the *glottis.* Along the sides of the glottis are thin membranes called *vocal cords.* These membranes usually hang loose, but they can be stretched and made to vibrate. They then produce sound in much the same way as it is produced by the vibrating strings of a musical instrument. The sound is the *voice.*

Speech. — The sounds of the voice will be higher or lower as the vocal cords are more or less tightened, and so vibrate faster or slower. By slight changes in the opening of the glottis the sound can also be made to vary in quality and quantity. The voice, coming out through the mouth, is shaped into speech by the teeth, tongue, palate, roof of mouth, and lips, under the direction of the mind.*

Care of the Voice. — Scarcely anything is more to be desired than a pleasant voice. The possessor of such a voice is sure to be heard when no heed is given to others, and his presence gives pleasure where that of others would give pain. To secure the possession of these pleasant tones, care must be taken not to put too great a strain upon the vocal cords in youth. Screaming, loud

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* Speech is chiefly a matter of imitation. Children who are accustomed to hear correct speech will usually speak correctly. During the first three or four years of school life, distinctness of speech may be promoted by giving rather more than the usual prominence to the syllables of words. Later the same object may be gained by short daily drills upon the *vocal elements* of the language.

wrangling, boisterous singing, and hallooing, all have a tendency to *break or harden the vocal cords*, so that afterward they can make none but coarse and harsh tones. Care must also be taken not to use the vocal cords much when the throat is sore from any cause.

EFFECTS OF ALCOHOL AND TOBACCO UPON THE SPECIAL SENSES AND THE VOICE.

Like the rest of the nervous system, the health and vigor of the special senses suffer from the use of alcoholic drinks, tobacco, and other narcotics, not only because the general tone of the body is reduced, but also because the nerves themselves are made less sensitive and steady. Both alcohol and tobacco, by their deadening influence on nerve matter, make the nerves of sense less able to get information and carry it to the brain; they make the brain less able to take notice of the reports brought to it by the special nerves of sense, less able to make good use of the information received, and less prompt and clear in the commands which it sends out through the nerves of motion; they also make the muscles to which commands are sent less able to do as they are directed.

Effects upon Touch. — Alcohol and tobacco deaden the nerves of the skin and thus make them less able to notice the peculiar qualities of objects with which they come in contact. It is said that drunken men have sometimes been fearfully burned without noticing the heat. The trembling hand of one whose nerves are thus "unstrung" is plainly unfitted for any work requiring steady nerves or delicacy of touch.

Effects upon Taste and Smell. — Alcohol dulls the sense of taste by its powerful effects upon the tongue. The biting effect of tobacco when chewed has a similar tendency, and smoking not only dulls the nerves but some-

times causes cancer on the lips and on the tongue. The delicacy of taste is also injured by disorders of the digestive organs, caused by these articles. Tobacco smoke dries the lining membrane of the nose, and thus diminishes its power to distinguish odors. The habitual use of snuff destroys the sense of smell almost entirely.

Effects upon Hearing. — The use of tobacco tends also to dry the delicate membrane of the ear and thus weaken the power to distinguish sounds. Tobacco sometimes produces inflammation of the middle ear and causes the nerves of hearing to bring to the mind false reports of ringing and roaring noises.

Effects upon the Eyes and the Sight. — Alcoholic drinks often cause congested, or "bleared," eyes in those who use them, in the same way as they cause red blotches on the skin. Alcohol may also injure the interior parts of the eye and produce what is known as "feebleness of sight of drinkers." Sometimes it causes the optic nerve to waste away until the images which fall upon the retina are no longer correctly reported to the mind. When this occurs, the sight is of course practically destroyed. Tobacco causes the pupil to open unduly, the sight to become confused, bright lines and "cobweb specks" to appear, and the images to remain on the retina much longer than they should.

Effects upon the Voice. — Alcohol and tobacco are very injurious to the voice, both by their direct effects upon the organs of speech and by diminishing the ability of the mind to control their action. The "thickened" speech of the drunkard is generally recognized. The "smoker's sore throat" and "smoker's tongue" are diseases familiar to medical men; they diminish the smoothness and purity of the tones and render the voice rough and disagreeable.

HYGIENE OF THE ORGANS OF SPECIAL SENSE.

I. When things taste bad, we should examine them with great care, and know that they are not harmful before we eat them.

II. We should be careful not to injure the sense of taste by the use of tobacco and other pungent substances.

III. Things that smell bad should be avoided.

IV. We should try to know and enjoy pleasant odors and sounds, especially those occurring in nature.

V. Keep all hard instruments out of the ear passages.

VI. Do not sit facing the light.

VII. Do not use the eyes much in a dim light.

VIII. Do not try to study or look closely, with cross lights or other uncertain and varying lights.

IX. Do not attempt to use your eyes much, when they give notice of exhaustion by sleepiness or pain.

X. Do not strain the vocal cords by continued loud and high tones in singing or in speech.

XI. Use the voice gently at the period when it is "changing," and always when there is any inflammation of the throat.

SOMETHING TO FIND OUT.

1. What part of the skin is best supplied with nerves of sense, and is therefore the most sensitive?

2. What can we find out by the sense of touch?

3. Why does a piece of marble feel cooler than a piece of fur that lies by its side?

4. Does it ever happen that the marble feels warmer than the fur under the same conditions?

5. Why can we not taste a piece of marble?

6. How can we tell the flavor of a fruit that we have heard described but have never seen?

7. What old fable shows the folly of deciding upon the flavor of grapes that grow out of reach?

8. Why can we not relish the flavor of a peach just after taking quinine?

9. What difference does the nerve of taste perceive between the surface of a piece of iron and that of a piece of soft cotton cloth?

10. Why should we take considerable time for each of our meals?

11. Why should we not usually spend several hours at a meal?

12. Why are roses and lilacs so frequently planted about houses?

13. What would be the effect, if fragrant flowers could be planted around all homes?

14. Why should we object to having a tannery or a slaughterhouse put up near our dwelling?

15. In what way can we turn to profitable account the decaying vegetable and animal substances which give off bad odors?

16. Why should we cultivate a liking for pleasant odors, and learn to discriminate between them?

17. What animals are noted for keenness of scent? Of what use is this sense to them?

18. What are some of the disadvantages of being deaf?

19. What pleasures of a high character do we get through the ear?

20. What special charms has an early morning walk in the country in summer?

21. When near by, why is the shrill whistle of a locomotive or the clang of a gong disagreeable?

22. Read from Goldsmith's "Deserted Village" the

description of summer evening sounds. What sounds are described, and why do they all make so pleasant an impression?

23. What advantage has the cultivated musician over one who has no taste for music?

24. What difference in shape do you notice between the pupil of a cat's eye and that of your own?

25. What difference do you notice in the iris of the eyes of different persons?

26. What in other parts of the body corresponds to the coloring of the iris, and the black coloring matter of the interior of the eye?

27. What is the color of the eyes of an albino, and why is his sight defective?

28. What are some of the useful ideas which we get through the eye?

29. What pleasurable emotions come from traveling among the mountains?

30. What from observing the sea? What from a walk in the garden?

31. How does voice differ from speech?

32. What are some of the disadvantages of a harsh voice?

33. What does a pleasant voice indicate?

34. Why should not little children be permitted to sing "at the top of their voices"?

35. What advantage comes from always hearing clear and pleasant tones in speech?

TOPICAL ANALYSIS OF CHAPTER XII.

How the Mind gets Ideas and expresses them.

Use of the Special Senses.
1. To carry sensations to the mind.
2. To produce ideas in the mind.

The Sense of Touch.
1. A general as well as special sense.
2. Special when used for getting knowledge.
3. Very important for many purposes.
4. The blind use it in place of sight.

The Sense of Taste.
1. Taste a sentinel guarding the stomach.
2. The nerves of taste.
3. How flavors are perceived.
4. Palatable foods.

The Sense of Smell.
1. The nerves of smell.
2. How odors are perceived.
3. Agreeable and disagreeable odors.
4. A guard to eating and breathing.

The Sense of Hearing.
1. Sound vibrations: the auditory nerve — hearing.
2. The ear: external — middle — internal.
3. Care of the ear.

The Sense of Seeing.
1. Light vibrations: the optic nerve — sight.
2. Need of light:
   1. To protect the body from injury.
   2. To observe beauty in the world.
3. The eye: form and position — structure — muscles.
4. Care of the eye: direction of light — intensity of light — injuries and remedies.

The Organs of Speech.
1. The need of expression.
2. The voice: the larynx — the glottis — the vocal cords.
3. Speech: pitch — quality — quantity — articulation.
4. Care of the voice — pleasant tones — avoid straining the voice.

Effects of Alcohol and Tobacco.
1. General and special.
2. Destroy delicacy of touch.
3. Dull the nerves of taste and smell.
4. Weaken and confuse the hearing.
5. Enfeeble and confuse the sight.
6. Render the voice rough and disagreeable.

Hygiene of the Organs of Special Sense.
Something to find out.

SUGGESTIONS FOR PRESERVING THE HEALTH OF TEACHERS AND PUPILS IN PUBLIC SCHOOLS.

(*Issued by the Department of Public Instruction of the State of New York and unanimously approved by the State Board of Health.*)

Seating — Cloakrooms. — Overcrowding endangers health and life of teacher and pupil. Not more than fifty, or at most sixty, children should be committed to the care of one teacher. To accommodate this number, not less than twelve hundred square feet of floor and eighteen thousand cubic feet of air space will suffice. Such an amount of space is represented by a room forty feet long, thirty feet wide, fifteen feet high.

Comfortable and convenient seats and desks should be provided. Desk accommodation should be graded and seats usually assigned according to size of pupils. Many bad habits of posture, sometimes deformity, may thus be avoided.

Cloakrooms or wardrobes, with pegs or hooks on which to hang outer garments and wet clothing, should be provided for each schoolroom.

Lighting — Care of Eyes. — Connected series of broad windows afford better light than separated narrow ones. Ordinary rooms are best lighted by a connected series of broad windows on one side only, or, if wide, on opposite sides.

Place desks so that the light comes from the left side, or from left and right sides, as pupils sit. Pupils should

never sit facing the light. Cross lights, excessive, dim and flickering lights, are also injurious. Curtains may partially remedy defects of ill-lighted rooms, and should be provided by the trustees.

Urge pupils to avoid excessively fine print, bringing eyes close to books or work, and long-continued fixing of the sight on any object. Urge the importance of adequate and shaded light for evening study. Do not require pupils to strain the eyes by reading dim blackboard work or indistinct charts at long distances.

Examination of objects and models, molding boards, outline maps, blackboard exercises, and oral instruction tire the eyes less than the use of text-books. Apparently defective eyes should be examined by a competent oculist. Pupils with imperfect vision should be favored accordingly. Pupils having contagious disease of the eyes (producing excessive purulent secretion) should leave school and seek medical treatment.

Temperature — Ventilation. — From opening to closing of sessions, schoolrooms should be kept constantly at 68° to 70° Fahr. At least once each hour, note the indication of a reliable thermometer, so placed as to show the mean temperature of the room at the level of pupils' desks.

Every schoolroom should be large, and should have some special well-devised system of ventilation. If such a system is provided, teachers are responsible for its intelligent and regular use. If not provided, it should be the first concern of every district. Much money expended on schools is wasted because of impure air in schoolrooms.

Open windows wide and thoroughly change the air in the room, at least once each hour of every session, and at all intermissions. Do not open windows at other times, unless certain that no pupil is chilled thereby. Do not

require pupils to remain in their seats when the room is aired. Caution them to avoid drafts of air at all times.

If any part of the room is excessively cold or hot, allow pupils to occupy the most comfortable positions consistent with good order. Stoves which heat only by radiation should never be used in schoolrooms, but should be replaced by some efficient method of convection to supply pure air properly warmed, in connection with outlets to provide thorough movement of the room atmosphere. If ordinary stoves are used, they should be so surrounded as to protect pupils sitting near them from excessive heat. Caution pupils to keep their clothing perfectly dry and avoid needless exposure to wet. Give every opportunity, consistent with good order, to dry wet clothing. Caution against improper clothing.

Nearly all colds and kindred diseases result from improper temperature, impure air, drafts, or improper clothing.

Overwork — Exercise and Rest. — Avoid overtaxing the powers of pupils, especially young children and those having feeble bodies and excitable natures. Life-long ill health or early death is, in many cases, the result of overwork in school. Do not confine young pupils to their work long at a time or many hours a day. Do not expect them to study at home. Avoid needless excitement in connection with examinations, promotions, and prize contests. Dissuade pupils not entirely strong from attempting too much.

Allow all pupils, especially young children, abundant opportunities for the recreation afforded by free and hearty outdoor play. Encourage systematic exercise by means of calisthenics, gymnastics, and proper athletic sports. If necessary, instruct pupils to avoid rudeness and dangerous violence.

Urge pupils to avoid whatever has a debilitating effect upon the system. Urge them to avoid late hours and to obtain sufficient sleep. Teachers and pupils should rest when fatigued as conscientiously as they work when rested. Allow and advise pupils evidently ill to go home and remain until able to return with safety.

Eating — Drinking. — Advise pupils who take their midday meal at school to bring sufficient food and eat it at the accustomed hour. Discourage eating at other times unless the system really demands food. The habit of eating hurriedly and immediately afterwards rushing out to play, or of eating while at play, is injurious.

Be certain that drinking water is not impure from stagnation or poisoned by drainage from vaults and similar sources of contamination. Many schools and communities have been poisoned in that way. Do not keep water in pails painted on the inside. Deter pupils from frequent drinking as a mere habit. Teach them to avoid waste of saliva by expectoration. Especially inculcate the injurious effects of stimulants and narcotics.

Cleanliness — Neatness. — Keep schoolrooms and outbuildings scrupulously clean, and school premises free from malarial or unsightly accumulations of all kinds.

Urge upon pupils cleanliness of person and of clothing. Unclean bodies and soiled clothing may do much to vitiate the air of schoolrooms. Neglect of cleanliness produces bodily discomfort and frequently disease, renders pupils vicious in various ways, and causes many evil actions.

Trustees should provide at the expense of the district wash basins, towels, looking-glass, and other necessaries for this purpose. Teachers should encourage pupils to use these articles when occasion demands. Pupils

should remember that habits of neatness, good taste, and politeness may be as useful in life as the lessons learned from their books.

Provisions for Decency — Outhouses. — In numerous districts there is a disgusting, degrading, and in every way harmful, neglect of sanitary cleanliness about the school premises, especially as regards outhouses. Such neglect is a relic of barbarism, and should not be tolerated in any civilized community. Public health, the bodily welfare of children, and their moral safety require careful and persistent attention to this matter.

An entirely separate and well-constructed building should be provided for each sex. It and its approaches should be carefully protected from prurient observers. Great care should be exercised to prevent these buildings from becoming offensive.

Trustees are responsible for this. Unsuitable outhouses are nuisances, and any trustee has a legal right, upon the order of the School Commissioner, to abate such nuisances at an expense of not more than twenty-five dollars. When the district is wholly unprovided with outbuildings the trustee has a right, upon the order of either the School Commissioner or the State Superintendent, to make such provision at an expense of not more than fifty dollars.

Trustees should see that these buildings are kept scrupulously clean. Teachers should know their condition at all times, and should enforce needed regulations concerning them. Pupils especially should remember that they are chiefly responsible for cleanliness and decency in respect to these matters, and that in regard to them their conduct at school will be taken by others as an index of their training and habits at home.

Contagious Diseases. — Trustees may, after ten days'

notice, debar unvaccinated pupils from attending school until vaccinated.

Pupils found to have any contagious disease — small-pox, diphtheria, typhus fever, typhoid fever, scarlet fever, measles, whooping cough — should at once and continuously absent themselves from school until a competent physician certifies that their return involves no exposure to others.

In case of reasonable doubt as to matters affecting the health of pupils, consult the local Health Officer, or, if necessary, the State Board of Health at Albany.

STATE BOARD OF HEALTH OF NEW YORK,
ALBANY, *January 14, 1886.*

JAMES E. MORRISON, Esq., *Superintendent of Public Instruction:*

DEAR SIR: I have much pleasure in transmitting to you the inclosed resolution, unanimously adopted by the State Board of Health, in approval of the suggestions for preserving the health of teachers and pupils in public schools, forwarded by you for consideration. I am, sir, faithfully yours,

ALFRED LUDLOW CARROLL, *Secretary.*

At a special meeting of the State Board of Health, on the 14th of January, 1886, the above suggestions for preserving the health of teachers and pupils in public schools were considered, and, on motion, it was

Resolved, That the suggestions for school teachers, submitted by the Superintendent of Public Instruction, be and hereby are approved.

Resolved, That the paper be returned to the Superintendent of Public Instruction, with the request that it be printed and circulated by him.

ALFRED LUDLOW CARROLL, *Secretary.*

January 15, 1886.

STATE OF NEW YORK: DEPARTMENT OF PUBLIC INSTRUCTION,
SUPERINTENDENT'S OFFICE, ALBANY, *January 25, 1886.*

To School Commissioners:

It is hereby ordered that one or more copies of the above suggestions be transmitted by the School Commissioners to the local school authorities of every School District under their charge, for the information and guidance of school officers, teachers, and pupils.

JAMES E. MORRISON,
State Superintendent of Public Instruction.

WHAT THE WORDS MEAN.

Ab-do'men (Latin, *abdo*, to hide). The largest cavity of the body, situated beneath the level of the diaphragm, and containing the liver, stomach, intestines, etc.; the belly.

Ab-sorb'ents (Latin, *ab*, and *sorbeo*, to suck up). The lymphatic vessels which take part in the process of absorption.

Ab-sorp'tion. The process of sucking up fluids by means of an animal membrane.

Ac-cel'er-a-tor (Latin, *celer*, quick). That which quickens motion or action.

A-ce'tic (Latin, *aceo*, to be sour). Relating to the essential constituent of vinegar.

Ac'id (Latin, *acidus*, from *aceo*, to be sour). A substance usually sour, sharp, or biting to the taste.

Ad'am's Ap'ple. An angular projection of cartilage in the front of the neck. It is particularly prominent in males, and is so called from a notion that it was caused by the apple sticking in the throat of our first parent.

Al-bi'no (Italian, *albino*, whitish). A person having a peculiar whiteness of the skin and hair, and a redness of the iris and pupil of the eye.

Al-bu'men (Latin, *albus*, white). An organic substance resembling white of egg.

Al-bu'mi-noids (Latin, *albumen*, and Greek *eidos*, form). A class of substances resembling albumen; they may be derived from either the animal or the vegetable kingdom.

Al'co-hol (Arabic, *al kohl*, a powder to paint the eyebrows with). The intoxicating element of spirituous liquors.

Al-i-men'ta-ry Ca-nal' (Latin, *alimentarius*, from *alo*, to nourish). A long tube, of varying form and size in its different parts, in which the digestion of the food, or "aliment," is performed. It comprises the

mouth, the pharynx, the esophagus, the stomach, and the small and the large intestine.

Al'ka-li (Arabic, *al kali*, the soda plant). A name given to certain substances, such as soda, potash, and the like, which have the power of combining with acids to form salts.

A-nat'o-my (Greek, *anatome*, cutting up, dissection). The study of the different parts and the structure of the body.

Am'y-loid (Greek, *amulon*, fine meal, and *eidos*, form). A substance similar to *amyle*, which is composed of ten parts of carbon and eleven of hydrogen.

A-or'ta (Greek, *aorteomai*, to be lifted up). The largest artery of the body, and main trunk of all the arteries. It arises from the left ventricle of the heart. The name was first applied to the two large branches of the trachea, which appear to be lifted up by the heart.

Ap-pend'age (Latin, *ad*, to, and *pendeo*, to hang). Something added to a principal or greater thing.

A'que-ous Hu'mor (Latin, *aqua*, water). A few drops of watery, colorless fluid occupying the space between the cornea and crystalline lens.

A-ro'ma (Latin). The agreeable odor of plants or other substances.

Ar-te'ri-al Blood. The bright-red blood in the left side of the heart and the arteries of the general circulation.

Ar'ter-y (Greek, *aer*, air, and *tereo*, to keep). A vessel conveying the blood from the heart outward to the organs; so called because the ancients thought these vessels contained air.

Ar-tic-u-la'tion (Latin, *articulo*, to form a joint). The movable union of bones; a joint.

Ath-let'ic (Greek, *athleo*, to contend for a prize). Belonging to wrestling, boxing, running, and other manly exercises and sports.

Au'di-to-ry Nerve (Latin, *audio*, to hear). The special nerve of the sense of hearing.

Au'ri-cle (Latin, *auricula*, the outer ear). The smaller and thinner chamber of the heart on each side, which receive the blood directly from the veins; so called from a fancied resemblance in shape to a dog's ear.

Au-to-mat'ic (Greek, *automatos*, self-moving). Self-acting; not depending on the will.

Bi'ceps (Latin). A muscle situated upon the front part of the arm above the elbow, which serves to bend the elbow joint.

Bi-cus'pid (Latin, *bi*, two, and *cuspis*, prominence). The name of the fourth and fifth teeth on each side of the jaw; possessing two prominences.

Bile. The gall, or peculiar secretion of the liver; a sticky, yellowish fiuid, and very bitter to the taste.

Blonde. Of a fair, or light, color or complexion.

Bone. A firm, hard substance, of a white or pale-rose color, composing the skeleton or firmer part of the body.

Brain. The mass of nervous substance contained in the cavity of the skull.

Bron'chi (Greek, *bronchos*, the windpipe). The branches into which the trachea is divided, and which end in the air cells of the lungs.

Bru-nette'. Of a brown or dark color or complexion.

Ca-lis-then'ics (Greek, *kalos*, beautiful, and *sthenos*, strength). The practice of healthful exercise of the body and limbs, to give strength and grace of movement.

Cal'lus (Latin, *calleo*, to be thick-skinned). Any excessive hardness of the skin, caused by friction or pressure.

Ca-nal' (Latin, *canna*, a pipe). In the body, any tube or passage.

Ca-nine' Teeth (Latin, *canis*, a dog). The pointed teeth situated just outside the incisors, one on each side in each jaw; so called because they are very prominent in the dog, as well as in other flesh-eating animals.

Cap'il-la-ries (Latin, *capillus*, hair). The smallest blood vessels, between the arteries and the veins; so called from their minute or hair-like size.

Car-bon'ic Ac'id (Latin, *carbo*, coal). The gas which is present in the air expelled from the lungs; a waste product of the animal kingdom, and a food of the vegetable kingdom.

Car'di-a (Greek, *kardia*, heart). The upper opening of the stomach, through which the food enters from the esophagus; so called because it is situated near the heart.

Car'di-ac. Pertaining to the heart or to the cardia.

Car'ri-on (Latin, *caro*, flesh). The dead and decaying bodies of animals.

Car'ti-lage (Latin, *cartilago*). A firm, elastic substance, like India rubber, attached to the bones in various parts of the body, forming a part of the joints, air passages, nostrils, and ear.

Ca'se-in (Latin, *caseus*, cheese). The albuminoid substance of milk, forming the basis of cheese.

Cav'i-ty (Latin, *cavus*, hollow). A hollow, inclosed space.

Cer-e-bel'lum (Latin, diminutive of *cerebrum*, brain). The little brain, situated at the back and lower part of the head.

Cer'e-brum (Latin). The brain proper, occupying the entire upper portion of the skull. It is nearly divided into two equal parts, called

hemispheres, by a cleft extending backward from the front part of the head.

Chest. The upper part of the trunk of the body, inclosed by the spinal column behind, the ribs on the sides, and the breastbone in front.

Chlo'ral (a name formed from the first syllables of *chlorine* and *alcohol*). A liquid narcotic obtained by the action of chlorine upon alcohol.

Cho'roid (Greek, *chorion*, skin, and *eidos*, like). A brownish-black membrane forming the middle coat of the eyeball.

Chyle (Greek, *chulos*, juice). Chyme changed in the duodenum, and turned white by the emulsion of fats.

Chyme (Greek, *chumos*, juice). The pulpy liquid formed by digestion within the stomach.

Cir-cu-la'tion (Latin, *circulus*, a ring). The circuit or course of the blood through the blood vessels of the body, from the heart to the arteries, through the capillaries into the veins, and from the veins back to the heart.

Clav'i-cle (Latin, *clavis*, a key). A slender bone, shaped somewhat like a key, placed horizontally at the bottom of the neck, between the top of the breastbone and the point of the shoulder. The collar bone.

Col'lar Bone. The clavicle.

Con'cave (Latin, *concavus*, hollow). Curved or rounded, like the inside surface of a hollow globe.

Con-ges'tion (Latin, *con*, together, and *gero*, to bring). An unnatural gathering of blood in any part of the body.

Con-nect'ive Tis'sue. A tissue consisting of loose fibrous bundles, which is placed between the muscles and other parts.

Con-sump'tion (Latin, *consumo*, to take entirely). A disease of the lungs, attended with a fever and cough, and causing a gradual decay of the bodily powers.

Con-trac'tion (Latin, *con*, together, and *traho*, to draw). The active shortening of a muscle or muscular fiber.

Con'vex (Latin, *conveho*, to bring together). Curved or rounded, like the outside of a globe.

Con-vo-lu'tions (Latin, *convolvo*, to roll together). The foldings of the external surface of the brain.

Cor'ne-a (Latin, *cornu*, a horn). The transparent, horn-like substance which covers the front part of the eyeball, through which the light passes.

Cor'pus-cle (Latin, diminutive of *corpus*, a body). One of the minute disks, concave on both sides, which give to the blood its red

color; or one of the larger white globular bodies which the blood contains.

Crys'tal-line Lens (Latin, *crystallum*, ice). A transparent, circular body, rounded on its front and back surfaces, situated in the eye-ball, just behind the pupil.

Cus'pid (Latin, *cuspis*, a point). A pointed tooth next back of the incisors.

Cu'ti-cle (Latin, diminutive of *cutis*, the skin). The scarfskin; also called the *epidermis*.

Cu'tis Ve'ra (Latin). The true skin, lying beneath the cuticle; also called the *derma*.

Dan'druff. The small scales, or particles, which separate from the scarf-skin of the scalp.

De-lir'i-um (Latin). A state in which the ideas of a person are wild, irregular, and unconnected.

Den'tine (Latin, *dens*, a tooth). The bony or ivory-like part of the teeth, lying directly beneath the enamel.

Der'ma (Greek, the skin). The soft, moist, and thick underlying layer of the skin; the *true skin*, or *cutis vera*.

Di'a-phragm (Greek, *diaphragma*, a partition). The muscular sheet which separates the cavity of the chest from that of the abdomen.

Di-ges'tion (Latin, *di*, apart, and *gero*, to bear). The preparation of the food in the alimentary canal.

Dig'i-ti-grade (Latin, *digitus*, finger, and *gradior*, to walk). An animal that walks or steps on its toes.

Dis-ease'. An unhealthy condition of some part of the body.

Dis-til-la'tion (Latin, *destillo*, to drip). The extraction or separation of a liquid by making it take the form of vapor and then condensing the vapor.

Duct (Latin, *duco*, to lead). A narrow tube, usually designed to convey away a secretion from the gland in which it is produced.

Du-o-de'num (Latin, *duodeni*, twelve each). The first division of the small intestines, about twelve finger breadths long.

Dys-pep'si-a (Greek, *dus*, ill, and *pepto*, to digest). A disordered condition of the stomach in which the process of digestion is difficult or painful.

E-las-tic'i-ty. The property of bodies by which they recover their former figure or size after the removal of outside pressure or force.

En-am'el. The dense material which covers the crown of the tooth.

Ep-i-der'mis (Greek, *epi*, upon, and *derma* skin). The outer layer of the skin; the scarfskin, or cuticle.

Ep-i-glot'tis (Greek, *epi*, upon, and *glottis*). A leaf-shaped piece of cartilage which covers the top of the larynx during the act of swallowing.

Ep'i-lep-sy (Greek, *epilambano*, to seize or attack). A disease of the brain causing the patient to fall suddenly to the ground, and marked by loss of consciousness and by convulsions of the muscles.

E-soph'a-gus (Greek, *oiso*, to carry, and *phago*, to eat). The tube leading from the throat to the stomach, through which the food and drink pass in eating.

Ex-cre'tion (Latin, *excerno*, to purge out). The process by which the waste materials of the body are removed; also the materials excreted.

Ex'er-cise (Latin, *exerceo*, to keep busy). Effort or action of the body for the sake of training, or of keeping its organs and functions in a healthy state.

Ex-pan'sion (Latin, *ex*, out of, and *pando*, to open). The act of extending or spreading out.

Ex-pi-ra'tion (Latin, *expiro*, to breathe out). The act of forcing air out of the lungs.

Ex-ten'sor (Latin, *ex*, out, and *tendo*, to stretch). A muscle which serves to straighten or extend a joint.

Eu-sta'chi-an Tube. A membranous canal, extending from the fore part of the tympanum of the ear to the side of the pharynx; from Eustachi, an Italian anatomist.

Fe'mur (Latin). The thigh bone.

Fer'ment (Latin, *ferveo*, to boil). One of the minute living forms to which the process of fermentation is believed to be due.

Fer-men-ta'tion. The change, or falling to pieces, of substances and the recombination which takes place under the influence of the ferments.

Fi'ber (Latin, *fibra*, a thread). One of the string-like portions which constitute a part of the tissues of plants and animals.

Fi'bril (diminutive of fiber). A very small branch of a fiber.

Fi'brin (Latin, *fibra*, a fiber). The fibrous animal matter which constitutes the clot of blood.

Fib'u-la (Latin, that which serves to fasten two things together). The outer and smaller bone of the leg.

Flex'or (Latin, *flecto*, *flexum*, to bend). A muscle which serves to bend a limb or joint.

Flip'per. The broad fin of a fish.

Fol'li-cle (Latin, diminutive of *follis*, a bag). A little pouch or depression in a membrane; it has generally a secretory function.

Func'tion (Latin, *fungor, functus*, to perform). The office performed by any organ of the body.

Fun'gus (Latin, mushroom). A plant, like the mushroom, which almost always grows upon and gets its nourishment from other plants to which it attaches itself.

Gan'gli-on (Greek, *ganglion*, a knot). A knot-like swelling in the course of a nerve; a smaller nerve center.

Gas'tric (Greek, *gaster*, the stomach). Pertaining to the stomach.

Gel'a-tin (Latin, *gelo*, to congeal). An animal substance which dissolves in hot water, and forms a jelly on cooling.

Gland (Latin, *glands*, an acorn). An organ consisting of follicles and ducts, with numerous blood vessels; it separates some particular fluid from the blood.

Glot'tis (Greek, *glotta*, the tongue). The narrow opening between the vocal cords in the upper part of the larynx, by which it communicates with the throat.

Glu'cose (Greek, *glucus*, sweet). A sugar less soluble and less sweet than cane sugar.

Glu'ten (Latin). Literally, glue; the gluey, albuminous matter of wheat flour.

Gus'ta-to-ry Nerve (Latin, *gusto*, to taste). The nerve of taste supplying the front part of the tongue.

Gym-nas'tics (Greek, *gumnazo*, to exercise). The practice of athletic exercises.

Hem'or-rhage (Greek, *haima*, blood, and *regnumi*, to burst). Bleeding, or loss of blood.

He-red'i-ty (Latin, *hereditas*, heirship). The law by which living beings tend to repeat themselves in their descendants.

Hic'cough. A spasm of some of the muscles used in breathing, accompanied by a shutting of the glottis and a sudden sound.

Hu'me-rus (Latin). The large bone of the arm between the shoulder and the elbow.

Hu'mor (Latin). Moisture: the humors are transparent contents of the eyeball.

Hy'gi-ene (Greek, *hugieia*, health). The art of preserving health and preventing disease.

I-de'a (Greek, outward appearance). The complete conception of an object.

In-ci'sor (Latin, *incido*, to cut). Applied to the four front teeth of both jaws, which have sharp, cutting edges.

In-den-ta'tion (Latin, *in*, and *dens*, a tooth). A notch in the margin of anything.

In-fe'ri-or Ve'na Ca'va (Latin, lower hollow vein). The chief vein of the lower part of the body.

In-flam-ma'tion (Latin, prefix *in*, and *flammo*, to flame). A peculiar diseased condition of any part of an animal body.

In-gre'di-ent (Latin, *ingredior*, to go into). That which enters into a compound as one of its constituents.

In-hib'i-to-ry (Latin, *in*, not, and *habeo*, to have). Tending to check or hold back.

In-spi-ra'tion (Latin, *in*, and *spiro*, *spiratum*, to breathe). The act of drawing in the breath.

In-ter-cos'tal Mus'cles (Latin, *inter*, between, and *costa*, a rib). The muscles which are situated between the ribs, and which move the ribs in respiration.

In-tes'ti-nal Juice. A sticky secretion produced by the lining membrane of the small intestine.

In-tes'tine (Latin, *intus*, within). The part of the alimentary canal which is continuous with the lower end of the stomach; also called the bowels.

I'ris (Latin, *iris*, the rainbow). The thin, muscular ring which lies between the cornea and crystalline lens, and which gives the eye its brown, blue, or other color.

Jaun'dice (French, *jaune*, yellow). A disease in which the skin assumes a yellowish color, supposed to be caused by an excess of bile.

Lac'te-als (Latin, *lac*, *lactis*, milk). The absorbent vessels of the small intestines; during digestion they are filled with chyle, which has a milky appearance.

Lar'ynx (Greek). The box of cartilage situated at the top of the windpipe, through which the air passes from the throat into the trachea; the organ of the voice.

Lens (Latin). Literally, a lentil; a piece of transparent glass or other substance so shaped as either to bring together or disperse the rays of light.

Lig'a-ment (Latin, *ligo*, to bind). A fibrous band or cord, serving to bind bones or other solid parts together.

Liv'er. The largest gland in the body, reddish in color, situated mainly on the right side, below the diaphragm. From the venous blood passing through it, it secretes bile. The liver produces from the blood an animal starch.

Lobe. A round, projecting part of an organ, as of the liver, lungs, or brain.

Loin. That part of an animal just above the hip bone.

Lu'bri-cate. To make smooth or slippery.

Lung. One of the two organs of respiration in an air-breathing animal.

Lymph (Latin, *lympha*, spring water). The colorless, watery fluid conveyed by the lymphatic vessels.

Lym-phat'ic Ves'sels. A set of very thin, delicate vessels, which absorb the lymph from the tissues of the body, and convey it inward toward the center of the venous system.

Mac-a-ro'ni (Greek, *makar*, blessed). An article of food, composed chiefly of wheat flour made into long, slender tubes, and much used in Italy.

Mar'row. The soft, fatty substance contained in the central cavities of the bones: the spinal marrow, however, is composed of nervous tissue.

Mas'se-ter (Greek, *massaomai*, to chew). A strong muscle situated upon the side of the face, which moves the lower jaw from below upward in chewing.

Mas-ti-ca'tion (Latin, *mastico*, to chew). The act of cutting and grinding the food to pieces by means of the teeth.

Me-dul'la Ob-lon-ga'ta (Latin). The "oblong marrow," or nervous cord, which is continuous with the spinal cord within the skull.

Mem'brane (Latin, *membrum*, a limb or member). A thin layer of tissue serving to cover some part of the body.

Mi'cro-scope (Greek, *mikros*, small, and *skopeo*, to look at). An optical instrument which magnifies objects.

Mo'lar (Latin, *mola*, a mill). The name applied to the three back teeth of each side of the jaw, which are adapted for grinding the food like millstones.

Mold (Latin, *molo*, to grind or bruise). The downy growth of microscopic plants, which forms on bodies that lie long in warm and damp air.

Mor'phine (Greek, *Morpheus*, the god of dreams or sleep). A narcotic, or sleep-producing drug, extracted from opium.

Mo'tor (Latin, *moveo*, *motum*, to move). Causing motion; the name of those nerves which conduct to the muscles the stimulus which causes them to contract.

Mu'cous Mem'brane. The thin layer of tissue which covers those internal cavities or passages which communicate with the external air.

Mu'cus (Latin). The sticky fluid which is secreted by mucous membranes, and which serves to keep them in a moist condition.

Mu-ri-at'ic Ac'id. An acid consisting of one part of hydrogen and one of chlorine.

Mus'cles (Latin, *musculus*, a little mouse). A band of fibers acting as an organ of motion in animal bodies. The *voluntary* muscles act in obedi-

ence to the will, and contract suddenly; the *involuntary* muscles do not obey the will, and contract slowly.

Nar-cot'ic (Greek, *narkao*, to benumb). A medicine which, in poisonous doses, produces stupor, convulsions, and sometimes death.

Na'sal (Latin, *nasus*, the nose). Pertaining to the nose; the *nasal cavities* contain the special nerve of smell.

Nau'se-a (Greek, *naus*, a ship). A sickness of the stomach similar to that caused by the motion of a ship at sea.

Nerve (Greek, *neuron*, a cord or string). A glistening, white cord, shaped like a tube, and connecting the brain or spinal cord with some other organ of the body. The nerves are the telegraph wires of the body.

Nerve Fi'ber. A very slender thread of nervous tissue found in the nerves; it is of a white color.

Nos'tril (Anglo-Saxon, *nosu*, nose, and *thyrl*, a hole). One of the two outer openings of the nose.

Nur'ture. To train up with care; the food and attention necessary to such training.

Nu-tri'tion (Latin, *nutrio*, to nourish). The processes by which the nourishment of the body is accomplished.

Ol-fac'to-ry (Latin, *olfacio*, to smell). Pertaining to the sense of smell.

O'pi-um. A narcotic drug obtained from the juice of the white poppy.

Op'tic (Greek, *opto*, to see). Pertaining to the sense of sight.

Or'gan (Greek, *organon*, an instrument). Any part of the body which is adapted to perform a particular service, such as the heart, the stomach, the brain.

Ox-i-da'tion. The combination of oxygen with metals and other substances.

Ox'y-gen (Greek, *oxus*, sharp, and *genein*, to bring forth). A gas forming one fifth part, by bulk, of the atmosphere, and essential to respiration.

Pal'ate (Latin, *palatum*, the palate). The roof of the mouth, consisting of the hard and soft palate.

Pan'cre-as (Greek, *pas*, *pantos*, all, and *kreas*, flesh). A long, flat gland placed behind the stomach: in the lower animals this organ is called the *sweetbread.*

Pan-cre-at'ic Juice. The secretion produced by the pancreas.

Pa-pil'læ (Latin, plural of *papilla*). The minute elevations in which terminate the fibers of the nerves of touch and taste.

Pa-ral'y-sis (Greek, *paraluo*, to loosen). A disease of the nervous system marked by the loss of sensation, or voluntary motion, or both; **palsy.**

Pa-tel'la (Latin, diminutive of *patina*, a pan). The kneepan.

Pel'vis (Latin, a basin). The bony cavity at the lower part of the trunk; the hip bone.

Pep'sin (Greek, *pepto*, to digest). The essential principle of the gastric juice.

Per-i-car'di-um (Greek, *peri*, about, and *kardia*, heart). The sac inclosing the heart.

Per-i-os'te-um (Greek, *peri*, around, and *osteon*, a bone). A fibrous membrane surrounding the bones.

Per-spi-ra'tion (Latin, *perspiro*, to breathe through). The sweat, or watery fluid poured out from the skin; when visible, it is called *sensible* perspiration; when invisible, *insensible* perspiration.

Phar'ynx (Greek, *pharunx*, the throat). The muscular passage leading from the back part of the mouth to the esophagus.

Phys-i-ol'o-gy (Greek, *phusis*, nature, and *logos*, a discourse). The science of the functions of living, organized beings; the study of the natural actions of the living body.

Pig'ment (Latin, *pingo*, to paint). Coloring matter.

Plan'ti-grade (Latin, *planta*, the sole of the foot, and *gradior*, to walk). An animal that walks on the sole of the foot, as the bear.

Pleu'ra (Greek, a rib). A membrane covering the lung and lining the chest. There is one for each lung.

Pneu-mo'ni-a (Greek, *pneuma*, air, and *pneo*, to breathe). An inflammation affecting the air cells of the lungs.

Poi'son (Latin, *poto*, to drink). Any substance whose nature it is, when absorbed into the blood, to injure the health or destroy life.

Por'tal Vein (Latin, *porta*, a gateway). The venous trunk formed by the union of all the veins coming from the intestines, spleen, pancreas, and stomach. It conveys the blood to the liver.

Proc'ess (Latin, *procedo*, *processus*, to proceed, to go forth). Any projection from a surface. Also, a method of doing anything.

Pro'te-id (Greek, *protos*, first, and *eidos*, form). An element allied to nitrogen; a substance containing such elements; an albuminoid.

Pul'mo-na-ry (Latin, *pulmo*, *pulmonis*, the lungs). Pertaining to the lungs.

Pulse (Latin, *pello*, *pulsum*, to beat). The striking of an artery against the finger, occasioned by the contraction of the heart, commonly felt at the wrist.

Pun'gent (Latin, *pungo*, to prick). Sharply painful or biting.

Pu'pil (Latin, *pupilla*). The central, round opening in the iris, through which light passes into the depths of the eye.

Py-lo'rus (Greek, *puloros*, a gate keeper). The lower opening of the

stomach, through which the food passes into the intestine; so called on account of a circular band of muscular fibers by which the passage is guarded.

Qui'nine (Spanish, *quina*, Peruvian bark). An extract of Peruvian bark used to cure fever, and give vigor to the system.

Ra'di-us (Latin, a spoke of a wheel). The bone on the thumb side of the forearm.

Re'flex Ac'tion. An involuntary action of the nervous system, by which an external impression conducted by a sensory nerve is reflected, or changed into a motor impulse.

Res-pi-ra'tion (Latin, *re*, denoting repetition, and *spiro*, to breathe). The function of breathing, comprising two acts: *inspiration*, or breathing in, and *expiration*, or breathing out.

Ret'i-na (Latin, *rete*, a net). The membranous expansion of the optic nerve in the interior of the eyeball, which receives the impressions resulting in the sense of vision.

Rib. One of the long bones inclosing the cavity of the chest. In man there are twelve on each side. The upper seven are called *true ribs;* the other five are the *false ribs*, of which the last two are called *floating ribs.*

Sa-li'va (Latin). The moisture or fluids of the mouth, secreted by the salivary glands.

Sal'i-va-ry Gland. A gland which produces saliva.

Sar-to'ri-us (Latin, *sartor*, a tailor). The muscle which throws one leg across the other.

Scalp (Latin, *scalpo*, to cut). The part of the skin of the head usually covered with hair. It is the part cut off by Indian warriors as a token of victory over an enemy.

Scap'u-la. The shoulder blade.

Scarfskin. The outer layer of the skin; the *cuticle*, or *epidermis.*

Scle-rot'ic (Greek, *skleros*, hard). The tough, fibrous outer coat of the eyeball.

Se-ba'ceous (Latin, *sebum*, fat). Resembling fat; descriptive of the oily secretion by which the skin is kept flexible and soft.

Se-cre'tion (Latin, *secerno, secretum*, to separate). The process of separating from the blood some important fluid; the fluid is also called a secretion.

Sen-sa'tion (Latin, *sensus*, sense). The conscious perception of an external impression by the nervous system; a function of the brain.

Sen'so-ry Nerve (Latin, *sentio*, to perceive). A nerve of sense.

Se'rum (Latin, whey, buttermilk). The clear, watery fluid which separates from the clot of the blood. It contains, besides water, albumen and mineral substances.

Shaft. A long, slender body, like a stem or stalk.

Shoul'der Blade. The flat, triangular bone of the shoulder; the *scapula.*

Skel'e-ton (Greek, a dried body). The bony framework of an animal, the different parts of which are kept in their proper relative positions.

Skull (a shell or bone). The bony case which incloses the brain.

Sock'et (Latin, *soccus,* a kind of low-heeled shoe). An opening into which anything is fitted.

Spasm (Greek, *spasmos,* convulsion). A sudden, violent, and involuntary contraction of one or more muscles or muscular fibers.

Spe'cial Sense. A sense by which we receive particular sensations, differing from those of general sensibility; such as those of sight, hearing, taste, and smell.

Spe-cif'ic Grav'i-ty. The ratio of the weight of a body to the weight of an equal bulk of some other body, usually water, taken as the standard.

Spher'ic-al (Latin, *sphera,* a globe). Having the form of a sphere.

Spi'nal Col'umn. The connected vertebræ of the back; the backbone; the spine.

Spi'nal Cord. A cylinder-shaped mass of nervous matter situated in the cavity of the spinal column.

Spine (Latin, *spina,* a thorn). A projecting point or ridge of bone.

Spleen. An organ largely made up of small vessels, and situated within the abdomen, near the left extremity of the stomach.

Spore (Greek, *sporos,* a seed). One of the minute grains which in flowerless plants perform the function of seeds.

Ster'num (Greek, *sternon,* the breast). A flat, rectangular bone, extending vertically along the middle of the chest, to which the seven upper ribs are attached.

Stim'u-lant (Latin, *stimulo,* to prick or goad on). An agent which causes an increase of vital activity in the body or any of its parts.

Stri'a-ted (Latin, *strio,* to furnish with channels). Marked with fine parallel lines.

Sub-cla'vi-an Vein (Latin, *sub,* under, and *clavis,* a key). The great vein bringing back the blood from the arm and side of the head; so called because it is situated underneath the *clavicle,* or collar bone.

Su-pe'ri-or Ve'na Ca'va (Latin, upper hollow vein). The great vein of the upper part of the body.

Sur'ger-y. That branch of medical science which treats of manual operations for the healing of diseases or bodily injuries.

Su'ture (Latin, *suo,* to sew or stitch). The seam or joint which unites the bones of the skull.

Sym-pa-thet'ic Sys'tem of Nerves. A double chain of nervous ganglions connected together by numerous small nerves, situated chiefly in front of and on each side of the spinal column.

Symp'tom (Greek, *sun*, with, and *ptoma*, a fall). A sign or token of disease.

Sys-tem'ic. Belonging to the system, or body, as a whole.

Tar'tar. A hard crust which forms on the teeth, and is composed of salivary mucus, animal matter, and a compound of lime.

Tem'ple (Latin, *tempus*, time, and *tempora*, the temples). The part of the head between the ear and the forehead; so called because the hair begins to turn white with age in that portion of the scalp.

Ten'don (Latin, *tendo*, to stretch). The white, fibrous cord or band by which a muscle is attached to a bone; a sinew.

Tex'ture (Latin, *texo*, to weave). The particular arrangement of tissues that form an organ.

Tho-rac'ic Duct (Greek, *thorax*, the chest). A narrow tube running from below upward within the back part of the chest, which is the main trunk of the lymphatic vessels.

Tho'rax (Greek, *thorax*, a breastplate). The upper cavity of the trunk of the body, containing the lungs, heart, etc.; the chest.

Tib'i-a. The principal bone of the leg below the knee.

Tis'sue. Any substance or texture in the body formed of various elements, such as cells, fibers, blood vessels, etc., interwoven with each other.

To-bac'co (Indian, *tabaco*, the tube or pipe in which the Indians smoked the plant). A plant used for smoking and chewing and in snuff. It has a strong smell and a pungent taste.

Tra'che-a (Greek, *trachus*, rough). The windpipe, or the largest of the air passages; composed in part of rings of cartilage, which render its surface rough and uneven.

Trans-par'ent (Latin, *trans*, through, and *pareo*, to appear). Capable of allowing light to pass through. Transparent bodies can be seen through.

Tri'ceps (Latin, *tria*, three, and *caput*, head). The large muscle which straightens the arm, or that which extends the leg.

True Skin. The inner layer of the skin; the *cutis vera*, or *derma*.

Trunk. The body, apart from the limbs.

Tym'pa-num (Greek, *tumpanon*, a drum). The cavity of the middle ear resembling a drum in being closed by two membranes, and in having communication with the atmosphere.

Ul'na (Latin, the elbow). The bone of the forearm on the little finger side.

Var'i-cose (Latin, *varix*, a dilated vein). Unnaturally enlarged — applied only to veins.

Vein. A vessel serving to convey the blood from the various organs inward to the heart.

Ve'nous (Latin, *vena*, a vein). Pertaining to, or contained within a vein.

Ven-ti-la'tion (Latin, *ventus*, wind). The introduction of fresh air into a room or building in such a manner as to keep the air within it in a pure condition.

Ven'tri-cle (Latin, *ventriculus*, a little stomach). The larger and thicker chamber of the heart, on each side, which receives the blood from the corresponding auricle, and discharges it into the artery.

Ver'te-bra (Latin, *vertebra*, a joint). One of twenty-six separate bones, called vertebræ, firmly jointed together to form the spinal column.

Ver'te-brate. Having a backbone formed of vertebræ.

Vi-bra'tion (Latin, *vibro*, to move to and fro). Quick motion to and fro.

Vi'nous (Latin, *vinum*, wine). Pertaining to wine.

Vi-tal'i-ty (Latin, *vita*, life). The state or quality of being full of life.

Vit're-ous (Latin, *vitrum*, glass). Having the nature of glass.

Vo'cal Cords (Latin, *vox*, *vocis*, the voice). Two elastic bands or ridges situated in the larynx; they are the essential parts of the organs of the voice. Their vibrations, communicated to the air, produce the sound of the voice.

Vol'un-ta-ry (Latin, *voluntas*, will). Under control or direction of the will.

Yeast (Anglo-Saxon, *gist*). A fungus, or low order of vegetable life, which is made up of cells that grow and multiply in a fermenting liquid, and to which the fermentation is understood to be due.

BONES OF THE BODY.

THE HEAD — 29 bones.

Skull (8 bones).
- Fron'tal (*frontale*, frontlet — one in forehead).
- Pa-ri'e-tal (*paries*, wall — one on each side of head).
- Tem'po-ral (*tempus*, time — one in each temple).
- Sphe'noid (*sphenos*, wedge — one at base of skull, between temples and cheeks).
- Eth'moid (*ethmos*, sieve — one between cavity of skull and upper part of nose).
- Oc-cip'i-tal (*occiput*, back of head — one at base of skull).

Ears (6 bones).*
- Mal'le-us (mallet — outermost of chain, one in each ear).
- In'cus (anvil — middle of chain, one in each ear).
- Sta'pes (stirrup — innermost of chain, one in each ear).

Face (14 bones).†
- Lach'ry-mal (*lacryma*, tear — one in each orbit).
- Na'sal (*nasus*, nose — two, forming bridge of nose).
- Ma'lar (*mala*, cheek — one in each cheek).
- Tur'bi-nate (*turben*, whirl — one in outer wall of each nostril).
- Pal'a-tal (*palatum*, palate — two, completing skeleton of hard palate).
- Vo'mer (plowshare — separating nostrils).
- Su-pe'ri-or Max'il-la-ry (*superior maxilla*, upper jaw-bone — two, forming upper jaw).
- In-fe'ri-or Max'il-la-ry (*inferior*, lower — one in lower jaw).

Hy'oid (*υ* and *eidos*, form, *u*-shaped — one in neck at base of tongue).

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* In early life there is a fourth bone between the incus and the stapes in each ear, but later it becomes a part of the incus.

† As the teeth are developed from the mucous membrane, they are not usually looked upon as belonging to the skeleton. The temporary, or "milk," set contains eight incisors, four canines, and eight molars. The permanent set may be tabulated as follows:

Teeth (32 in number).
- In-ci'sors (*incido*, to cut — four in the front of each jaw).
- Ca-nines' (*canis*, dog — one on each side of each jaw, behind the incisors).
- Bi-cus'pids (*bi*, two, and *cuspis*, prominence — two on each side of each jaw behind the canines).
- Mo'lars (*mola*, mill — three on each side of each jaw, behind the bicuspids).

THE TRUNK * — 57 bones.

Spine (24 bones).
- Cer'vi-cal Ver'te-bræ (*cervix*, neck — seven in the neck).
- Dor'sal Ver'te-bræ (*dorsum*, back — twelve in the back).
- Lum'bar Ver'te-bræ (*lumbus*, loin — five in the loins).

Shoulder (4 bones).
- Scap'u-la (shoulder blade — one on upper part of back on each side).
- Clav'i-cle (*clavis*, key — one on each side, between top of breastbone and point of shoulder).

Sternum (*sternon*, breast — one extending vertically along middle of chest.)

Ribs (24 bones).
- True (upper seven pairs attached to spine, and tied directly to breastbone by cartilages).
- False (lower five pairs attached to spine; three pairs tied to cartilages of preceding rib; two pairs "floating" unattached in front).

Pelvis (4 bones).
- In-nom'i-nate (*in*, not, and *nomino*, to name — two main bones of pelvis, forming hips).
- Sa'crum (sacred — one between innominate bones, formed of five consolidated vertebræ).
- Coc'cyx (cuckoo — one below sacrum, formed of four consolidated vertebræ).

THE LIMBS — 120 bones.

Upper (60 bones).†
- Hu'me-rus (upper arm — one in each arm).
- Ul'na (elbow — one in each forearm, joined to the humerus).
- Ra'di-us (spoke — one in exterior of each forearm, moving around ulna).
- Car'pal (*carpus*, wrist — eight in each wrist).
- Met-a-car'pal (*meta*, beyond, *carpos*, wrist — five in each hand, between wrist and fingers).
- Pha-lan'ges (battalions — three in each finger, two in each thumb.

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* Strictly, the scapula and the clavicle belong neither to the trunk nor the arms, but simply connect them. The sacrum and the coccyx may be classified as belonging to the spine.

† At the joints of the thumbs and great toes are pairs of small bones, eight in all, called sesamoid bones (*sesamon*, sesame seed, and *eidos*, like).

Lower (60 bones).

- Fe'mur (thigh bone — one in each leg).
- Pa-tel'la (little pan — one covering each kneejoint).
- Tib'i-a (shin bone — one in each leg, between knee and ankle).
- Fib'u-la (clasp — one bracing tibia in each leg).
- Tar'sal (*tarsos*, flat of the foot — seven in each instep).
- Met-a-tar'sal (*meta*, beyond, and *tarsos* — five in each foot, between ankle and toes).
- Pha-lan'ges (battalions — two in each great toe, three in each of the others).*

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* The confusion about the number of bones in the body arises from counting them at different ages and omitting different sets. The following successive additions will explain the various numbers:

General bones of the skeleton	200
Bones of the ears in adults	6
	206
Additional bones in the ear in children	2
	208
The permanent teeth	32
	240
The sesamoid bones	8
	248

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(These references do not include the definitions under the title "What the Words Mean.")

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